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13. ABSTRACT *(Maximum 200 words)*

A Site Investigation (SI) was conducted at four separate former underground storage tank (UST) locations. A total of nine USTs, at seven different locations, were removed as part of an on-going ANG tank removal program. Confirmation sampling performed at the time the tanks removed exhibited levels of contamination requiring further investigation at four of the locations, with two USTs at one of the locations. The former USTs were identified as; No. 591 adjacent to Building 659, No. 873 adjacent to Building 687, No. 801 adjacent to Building 680, and Nos. 651/652 adjacent to Building 665.

The findings of this SI found only low levels of contamination and recommended no further action. The Minnesota Pollution Control Agency issued a letter on 2 October 1996 accepting the findings and recommendations stating: "The Minnesota Pollution Control Agency (MPCA) Tanks and Emergency Response Section (TERS) staff has determined that your investigation and/or cleanup has adequately addressed the petroleum tank release at the sites listed above. Based on the information provided, the TERS staff has closed the release site files".

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SITE INVESTIGATION REPORT FOR FORMER UST SITE NOS. 1, 2, 3, AND 4

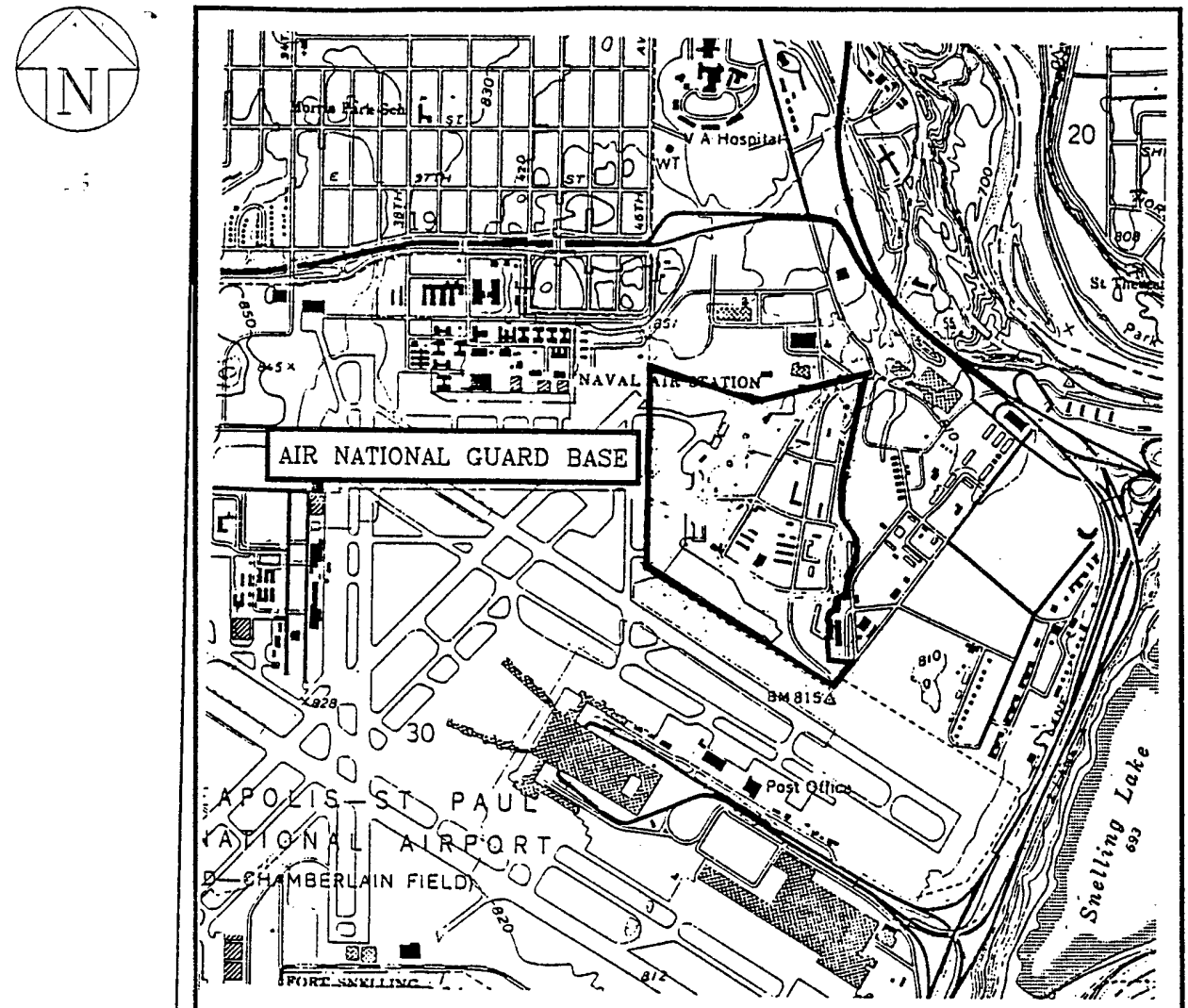
VOLUME I

133rd AIRLIFT WING
MINNESOTA AIR NATIONAL GUARD
MINNESOTA AIR NATIONAL GUARD BASE
MINNEAPOLIS, MINNESOTA

NOVEMBER 1996

Prepared For

ANGRC/CEVR
ANDREWS AFB, MARYLAND



SOURCE: 7.5 MINUTE ST. PAUL WEST QUADRANGLE. U.S. GEOLOGICAL SURVEY. 1972.

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SCALE IN FEET

INSIDE FRONT COVER

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SITE LOCATION IN THE STATE OF MINNESOTA

133rd AW, Minnesota ANGB
Minneapolis, Minnesota

OPTECH
OPERATIONAL TECHNOLOGIES CORPORATION

MAY 1996

SITE INVESTIGATION REPORT FOR FORMER UST SITE NOS. 1, 2, 3, AND 4

VOLUME I

133rd AIRLIFT WING
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MINNESOTA AIR NATIONAL GUARD BASE
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LIST OF ACRONYMS

AFRB	Air Force Reserve Base
ANGB	Air National Guard Base
ASTM	American Society for Testing and Materials
ATHA	Ambient temperature headspace analysis
AVGAS	Aviation Gasoline
AW	Airlift Wing
BEC	Barr Engineering Company
BH	Borehole
Bldg.	Building
BLS	Below Land Surface
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CAMS	Consolidate Aircraft Maintenance Section
° C	Degrees Centigrade
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm/s	centimeters per second
DRO	Diesel Range Organics
° F	Degrees Fahrenheit
FS	Feasibility Study
ft/day	feet per day
ft/ft	feet per foot
ft/yr	feet per year
GC	Gas Chromatograph
gpm	gallons per minute
GRO	Gasoline Range Organics
GW	Groundwater
ANGRC/CEVR	Air National Guard Readiness Center
HRLs	Health Risk Limits
HRS	Hazard Ranking System
HSA	Hollow-stem auger
IAP	International Airport
ID	Inner diameter
IDW	Investigation Derived Waste
IRP	Installation Restoration Program
MCL	Maximum Contaminant Level
MDH	Minnesota Department of Health
mgd	million gallons per day
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MNANG	Minnesota Air National Guard
MOGAS	Motor Vehicle Gasoline
MPCA	Minnesota Pollution Control Agency

LIST OF ACRONYMS (Concluded)

MS/MSD	Matrix Spike/Matrix Spike Duplicate
MSL	Mean Sea Level
MTBE	Methyl tertiary-butyl ether
MW	Monitoring Well
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
OpTech	Operational Technologies Corporation
OVM	Volatile Organic Monitor
PCBs	Polychlorinated Biphenyls
PID	Photoionization Detector
POL	Petroleum, Oil, and Lubricant
PPE	Personal Protection Equipment
ppb	parts per billion
ppm	parts per million
PVC	Polyvinyl chloride
QAPP	Quality Assurance Project Plan
RAL	Minnesota Recommended Allowable Limits
RI	Remedial Investigation
SARA	Superfund Amendments and Reauthorization Act
SI	Site Investigation
SPL	Southern Petroleum Laboratories, Inc.
SPT	Standard Penetration Test
SS	Soil Sample
TPH	Total Petroleum Hydrocarbons
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VOA	Volatile Organic Analysis
VOCs	Volatile Organic Compounds
WDNR	Wisconsin Department of Natural Resources

SITE INVESTIGATION REPORT

EXECUTIVE SUMMARY

A Site Investigation (SI) was conducted at the 133rd Airlift Wing (AW), Minnesota Air National Guard Base (ANGB), Minneapolis-St. Paul International Airport, Minneapolis, Minnesota. The Air National Guard, Environmental Division/Installation Restoration Branch (ANGRC/CEVR), authorized Operational Technologies Corporation (OpTech) to prepare an SI Work Plan and conduct the SI at the Minnesota ANGB. During the removal of nine underground storage tanks (USTs) and associated piping in July-August 1993, soil samples were collected for headspace samples and laboratory analyses, and several water samples were collected for laboratory analysis. Based on the sampling results, five UST sites were identified for further investigation to determine the extent of remaining soil contamination. The four sites investigated during the SI are identified as: UST – Site No. 1, the former UST No. 591, adjacent to Building (Bldg.) 659; UST – Site No. 2, the former UST No. 873, adjacent to Bldg. 687; UST – Site No. 3, the former UST No. 801, adjacent to Bldg. 680; and UST – Site No. 4, the former USTs No. 651/652, adjacent to former Bldg. 665. The SI was conducted as outlined in the SI Work Plan submitted to ANGRC/CEVR in June 1995 and approved in July 1995. The field work commenced at the 133rd AW on 31 July 1995 and was completed on 17 August 1995. OpTech returned the week of 17 September 1995 to conduct the second round of groundwater sampling and to install monitoring well 651-001MWB. A second groundwater sample from 651-001MWB was obtained on 26 October 1995.

UST – SITE NO. 1

UST – Site No. 1 is located on the north side of the Base next to Bldg. 659. The area is covered by grass with asphalt pavement on its eastern and northern edges. Ten soil samples from four soil boring locations and two groundwater samples from one monitoring well located downgradient from the UST excavation were collected at this site. Soil samples were analyzed for benzene, toluene, ethylbenzene and total xylenes (BTEX) by United States Environmental Protection Agency (USEPA) Method SW-846-8020 and total petroleum hydrocarbons diesel range organics (TPH-DRO) by modified Wisconsin Department of Natural Resources (WDNR) method. Groundwater samples were analyzed for volatile organic compounds (VOCs) by USEPA SW-846/8240 and TPH-DRO by WDNR method.

No BTEX compounds were detected in soil samples collected from the UST excavation during Bay West, Inc.'s, August 1993 UST removal activities. TPH-DRO was detected at a

concentration of 1,300 milligrams per kilogram (mg/kg) during the UST removal activities in one soil sample collected from the UST excavation floor at a depth of 10.0 feet below land surface (BLS) and at 280 mg/kg in one soil sample collected from the vent piping run at a depth of 2.0 feet BLS. No groundwater was encountered in the UST excavation.

During the August 1995 SI, BTEX and TPH-DRO were detected in soil samples collected with maximum concentrations of 3 micrograms per kilogram (μg/kg) and 4.1 mg/kg (detection limit of 4 mg/kg), respectively. No VOCs were detected in the groundwater samples collected from this site. TPH-DRO was detected in groundwater samples with a maximum concentration of 0.36 milligrams per liter (mg/L). No Minnesota Department of Health (MDH) Minnesota Health Risk Limits (HRLs) for drinking water have been established for TPH-DRO.

Based on the delineation results of the SI, soil contamination at levels of concern consists of residual concentrations of low volatile compounds (TPH-DRO) localized to one section of the UST excavation floor and along the former vent piping run. Significant contaminant migration is not apparent.

Based on the results of previous investigations and this SI, no further investigative or remedial actions for soil and groundwater are warranted. Site closure should be requested from the MPCA.

UST – SITE NO. 2

UST – Site No. 2 is located on the south central side of the Base next to Bldg. 687. The area is covered by asphalt pavement. Seven soil samples from three soil boring locations and two groundwater samples from one monitoring well located downgradient from the UST excavation were collected at this site. Soil samples were analyzed for VOCs by USEPA Method SW-846/8240 and TPH-DRO by modified WDNR method. Groundwater samples were analyzed for VOCs by USEPA Method SW-846/8240 and TPH-DRO by modified WDNR method.

No VOCs were detected in soil samples collected from the UST excavation during Bay West, Inc.'s, August 1993 UST removal activities. TPH-DRO was detected at a concentration of 24 mg/kg during the UST removal activities in one soil sample collected from the north sidewall of the UST excavation floor at a depth of 7.0 feet BLS and at 9 mg/kg in one soil sample collected from the south sidewall at a depth of 6.5 feet BLS. A water sample collected directly from the UST excavation during the Bay West, Inc., August 1993 removal activities exhibited a total VOC concentration of 1,194 micrograms per liter (μg/L) and TPH-DRO concentration

of 0.45 mg/L. The contamination detected in the water sample represents contact of groundwater with contaminated materials within the UST excavation and cannot be considered representative of groundwater conditions in native soils at the site.

During the August 1995 SI, no VOCs were detected in the soil samples collected from this site. TPH-DRO was detected at a concentration of 290 mg/kg in the near-surface (1.5 to 2.5 feet BLS) soil sample collected from soil boring 873-001BH. TPH-DRO detected in soil samples from all other sample intervals ranged from 7.4 to 18 mg/kg. No VOCs were detected in the groundwater samples collected at this site. TPH-DRO was only detected in the groundwater sample taken during the 16 August 1995 sampling round, at a concentration of 0.11 mg/L (detection limit of 0.1 mg/L). Based on the results of groundwater analyses conducted during the SI, no groundwater contamination has been confirmed outside of the UST excavation at the site.

Based on the delineation results of the SI, soil contamination at levels of concern exists as residual concentrations of low volatile compounds (TPH-DRO) at a depth of approximately 2.0 feet BLS, near the north edge of the UST excavation. Vertical delineation of the TPH-DRO indicates that the elevated concentrations are restricted to the upper few feet of the soil profile, underneath the asphalt paving and subgrade. TPH-DRO concentrations decrease rapidly with depth within the soil profile to 18 mg/kg or less. Based on the distribution and magnitude of TPH-DRO contamination, the potential for significant impact to groundwater is low.

Based on the results of previous investigations and this SI, no further investigative or remedial actions outside of the UST excavation are warranted. Site closure should be requested from the MPCA.

UST – SITE NO. 3

UST – Site No. 3 is located on the eastern side of the Base next to Bldg. 680. The area is covered by asphalt pavement and concrete taxiway. Seven soil samples from three soil boring locations and two groundwater samples from one monitoring well located downgradient from the UST excavation were collected at this site. Soil samples were analyzed for BTEX by USEPA Method SW-846/8020 and TPH-DRO by WDNR method (modified). The groundwater samples were analyzed for VOCs by USEPA Method SW-846/8240 and TPH-DRO by WDNR method (modified).

During the previous investigation, conducted during Bay West, Inc.'s, UST removal activities in September 1993, BTEX constituents were detected in soil samples from the excavation floor (13.0 feet BLS) at concentrations ranging up to 14 mg/kg. Benzene was detected in only one sample at a concentration of 0.23 mg/kg. TPH-DRO was detected in the excavation floor samples at a concentrations ranging from 880 to 12,000 mg/kg. A water sample collected directly from the UST excavation during the Bay West, Inc., August 1993 removal activities exhibited a total BTEX concentration of 203 μg/L (13 μg/L benzene) and a TPH-DRO concentration of 30 mg/L. The contamination detected in the water sample represents contact of groundwater with contaminated fill materials within the tank pit and can not be considered representative of groundwater conditions at the site.

During the August 1995 SI, one soil sample collected from a depth of 9.0 to 10.0 feet BLS in soil boring 801-001BH exhibited total BTEX concentration of 6.26 mg/kg. Benzene was present in the sample at 0.130 mg/kg; xylene at 5.2 mg/kg. Total BTEX concentrations in the other soil samples collected at the site were less than 0.005 mg/kg. TPH-DRO was detected at a concentration of 2,100 mg/kg in the 9.0- to 10.0-foot BLS soil sample collected from soil boring 801-001BH. TPH-DRO detected in soil samples from all other sample intervals were relatively low, ranging from 8.3 to 15.0 mg/kg. No VOCs were detected in the groundwater samples collected at this site. TPH-DRO was only detected in the groundwater sample taken during the 16 August 1995 sampling round at a concentration 0.19 mg/L (detection limit of 0.1 mg/L).

Based on the delineation results of the SI, soil contamination exists as residual concentrations of BTEX and TPH-DRO at a depth of approximately 10.0 feet BLS, just above bedrock and adjacent to the north edge of the UST excavation. The concentrations detected are consistent with residual contamination levels detected in excavation floor samples collected during the September 1993 UST removal activities. The northern extent of petroleum hydrocarbon contamination has not been delineated.

Based on the results of previous investigations and this SI, no further investigative or remedial actions outside of the UST excavation are warranted. Site closure should be requested from the MPCA.

UST – SITE NO. 4

UST – Site No. 4 is located on the north central side of the Base next to Bldg. 664. The area is covered by grass. Seventeen soil samples from six soil boring locations and eight groundwater samples from four monitoring wells were collected at this site. Soil samples were

analyzed for BTEX and methyl tertiary-butyl ether (MTBE) by USEPA Method SW-846/8020; TPH-DRO and total petroleum hydrocarbons gasoline range organics (TPH-GRO) by modified WDNR method; and total lead by USEPA Method SW-846/6010. Groundwater samples were analyzed for VOCs by USEPA Method SW8240; TPH-DRO and TPH-GRO by the WDNR method (modified); and for total lead by USEPA Method SW6010.

During the previous investigation, conducted during Bay West, Inc.'s, UST removal activities in September 1993, BTEX constituents were detected in soil samples from the excavation floor and sidewalls at concentrations ranging from non-detect to 8.5 mg/kg; no benzene was detected. TPH-DRO was detected in all soil samples at concentrations ranging from 150 mg/kg to 840 mg/kg. A water sample collected directly from the UST excavation during the Bay West, Inc., August 1993 removal activities exhibited a total BTEX concentration of 1,894 μg/L (74 μg/L benzene) and a TPH-DRO concentration of 1.9 mg/L. The contamination detected in the water sample represents contact of groundwater with contaminated fill materials within the tank pit and can not be considered representative of groundwater conditions at the site.

During the August 1995 SI, the highest BTEX concentrations were detected in near-surface soil samples from soil borings 651-007BH at the 1.0- to 2.0-foot interval and 651-002BH 0- to 1.5-foot interval at 2.2 mg/kg and 0.210 mg/kg, respectively. The maximum benzene concentration detected was 0.790 mg/kg detected in soil sample collected from soil boring 651-007BH at the 1.0- to 2.0-foot interval. Total BTEX concentrations in all soil samples collected from depths greater than 2.0 feet BLS ranged from 0.001 to 0.187 mg/kg (maximum benzene concentration of 0.036 mg/kg).

TPH-DRO concentrations detected in the SI soil samples collected from depth intervals less than 5.0 feet BLS ranged from non-detect to 320 mg/kg. The highest concentration of TPH-DRO was detected in soil sample collected from soil boring 651-003BH at the 1.0- to 2.0-foot interval. At depth intervals greater than 5.0 feet BLS, TPH-DRO was not detected in the soil samples. Only two soil samples exhibited TPH-GRO at concentrations of 50 mg/kg and 0.83 mg/kg. The maximum TPH-GRO concentration was detected in the soil sample collected from a depth of 1.0 to 2.0 feet BLS in soil boring 652-007BH. Total lead concentrations detected in soil samples ranged from non-detect to 100 mg/kg with an average concentration of 27 mg/kg. The observed range of background concentrations of soils in the Eastern United States range from <10 to 300 mg/kg (Shacklette and Boerngen, 1984).

A sheen and strong hydrocarbon odor was noted in groundwater samples collected from monitoring wells 651-001MWA and MW-4. No BTEX was detected in SI groundwater samples

collected from monitoring well 651-001MWA, located in the inferred downgradient direction from the UST excavation and screened within the perched water table during the first sampling event (17 August 1995) or second sampling event (21 September 1995) of groundwater sampling. TPH-DRO was detected in groundwater samples during the first sampling event at a concentration of 0.55 mg/L, but was not detected during the second sampling event.

Total BTEX concentrations in groundwater samples collected from monitoring wells 651-001MWB, 651-002MW, and MW-4, all completed in the shallow confined bedrock aquifer ranged from 50 μg/L (benzene at 6 μg/L) from monitoring well 652-002MW to 919 μg/L (benzene at 39 μg/L). No other VOCs were detected in the SI groundwater samples. The MDH HRL for benzene in groundwater is 10 μg/L; the Federal Maximum Contaminant Level (MCL) is 5 μg/L. TPH-DRO concentrations in groundwater samples collected from these monitoring wells ranged from 3.92 mg/L in monitoring well 651-001MWB to 0.57 mg/L in monitoring well 651-002MW. TPH-GRO concentrations in groundwater samples collected from these monitoring wells ranged from 29 mg/L in monitoring well 651-001MWB to 0.21 mg/L in monitoring well 651-002MW. No lead was detected in any of the groundwater samples collected during the SI.

Based on the results of previous investigations and the SI, the following conclusions regarding the extent and magnitude of contaminated soil and groundwater are presented:

- TPH-DRO concentrations at levels of concern were exhibited by soil samples collected from the UST excavation sidewalls and floor during Bay West, Inc.'s, tank removal activities.

- The distribution of petroleum hydrocarbon contaminants detected in soil samples from the SI soil borings indicates that the highest degree of residual soil contamination is restricted to depths less than two feet below surface. The shallow occurrence of the contaminated soil is more consistent with impact from a surface source rather than a buried UST system. Potential source candidates for the elevated levels of soil contamination could be surface spillage that occurred during operation of the facility or possibly spillage of residual contaminated soil and backfill removed from the UST excavation. The lateral extent of the near-surface soil contamination has not been delineated.

- The vertical extent of petroleum contamination in native soils outside the UST excavation has been defined to concentrations that do not pose a significant threat to human health or the environment.

- The concentrations of lead detected in soil samples during the SI do not pose a significant threat to human health or the environment.

- No petroleum hydrocarbon contamination was indicated in groundwater samples collected from the perched groundwater table at the site.

- Benzene concentrations greater than MDH HRLs and Federal MCLs has been confirmed in groundwater samples collected from the shallow confined aquifer within the Platteville Limestone. TPH-DRO and TPH-GRO concentrations at levels of concern have also been confirmed in the groundwater samples; however, no MDH HRLs or Federal MCLs are established for TPH in groundwater. Cleanup levels for groundwater contaminants having no established MDH HRL are determined by the MPCA on a site-specific basis.

- The horizontal extent of petroleum hydrocarbon contamination in groundwater within the shallow confined aquifer was not defined at the site by the SI.

Due to the limited (shallow) vertical extent of soils contaminated by elevated TPH concentrations, and the relatively low mobility of TPH compounds, the potential for shallow contaminated soils identified during the SI to significantly impact groundwater is low. The TPH concentrations detected are low enough that normal human activities at the site would not result in a significant threat to human health. Additionally, site conditions are suitable to allow natural degradation to reduce the level of TPH contamination over time. Therefore, no additional delineation or remedial efforts with respect to shallow soil contamination are warranted.

There are no complete groundwater pathways to sensitive receptors at or adjacent to the site. The nearest water wells listed are approximately 3,000 feet away and are not completed within the contaminated interval. Well records indicate that the wells produce groundwater from the Jordan Sandstone which is separated from shallower aquifers by a confining unit. Therefore, no additional investigative or remedial measures are recommended for contaminated groundwater.

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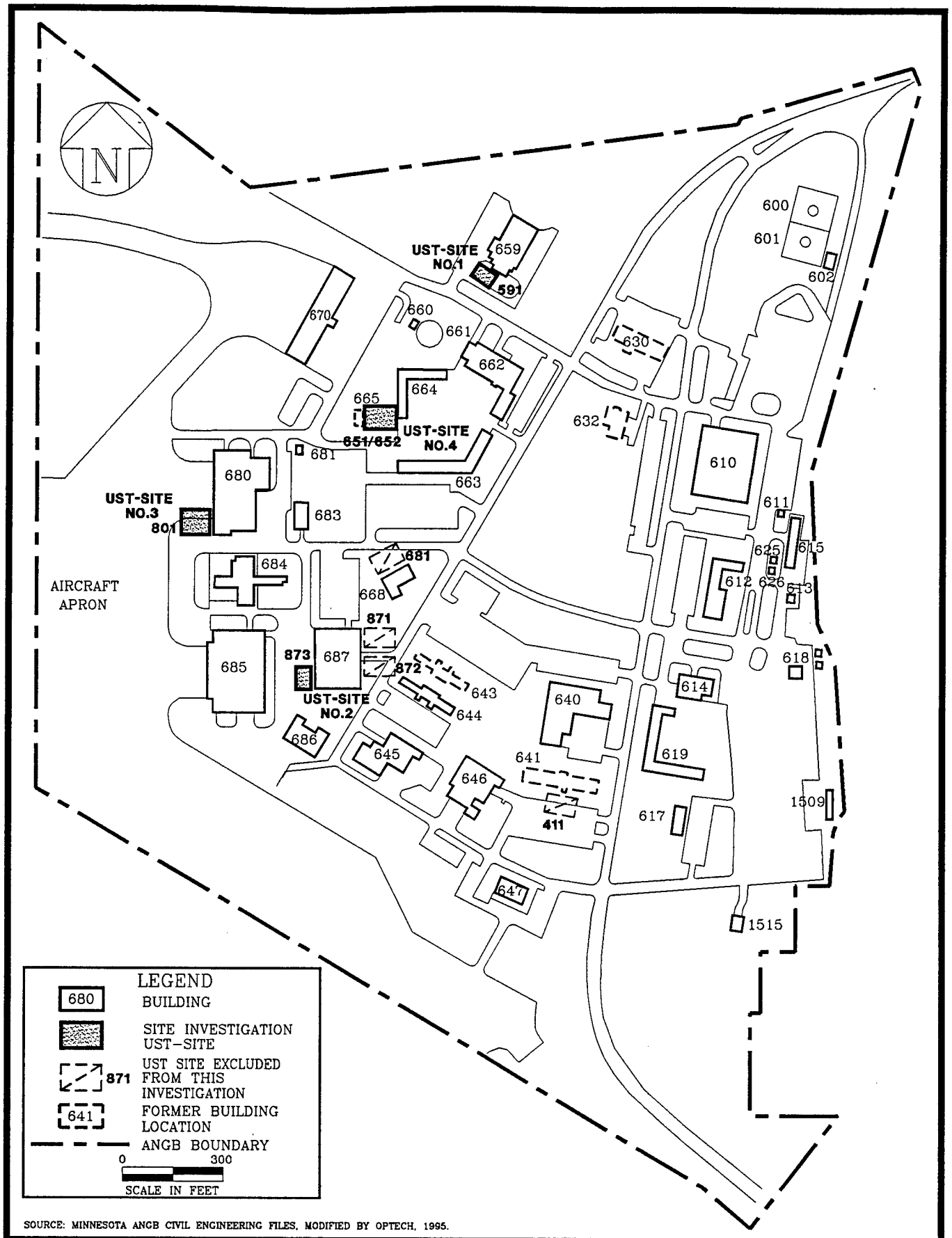
SECTION 1.0 INTRODUCTION

1.1 BACKGROUND

This Site Investigation (SI) Report presents the results of investigation activities conducted by Operational Technologies Corporation (OpTech) at four former underground storage tank (UST) sites at the 133rd Airlift Wing (AW), Minnesota Air National Guard Base (ANGB), Minneapolis-St. Paul International Airport, Minneapolis, Minnesota (see Inside Front Cover Figure). The SI was conducted as outlined in the SI Work Plan submitted to the Air National Guard Readiness Center (ANGRC/CEVR) in June 1995 and approved in July 1995. The SI was conducted in accordance with applicable Minnesota Pollution Control Agency (MPCA) and Minnesota Department of Health guidelines.

Bay West, Inc., Environmental Services (Bay West, Inc.), from St. Paul, Minnesota, was the Minnesota Air National Guard's (MNANG) general contractor for the removal of nine USTs at the Minnesota ANGB in July-August 1993. The nine USTs were removed from seven different sites; two of the sites contained two tanks each. The USTs varied in capacity from 1,000 to 50,000 gallons and ranged from 12 to 36 years in age. The USTs were used to store aviation gasoline (AVGAS) and/or No. 2 fuel oil, with the exception of UST No. 873, which was used as an oil/water separator and to store waste oil. Seven of the nine USTs had failed tank tightness tests. (Bay West, 1993)

During the removal of USTs and associated piping, soil samples were collected by Bay West for headspace sample and laboratory analyses, and several water samples were collected for laboratory analysis. Based on the sampling results, five UST sites were identified for further investigation to determine the extent of remaining soil contamination. The remaining sites are under consideration by the MPCA Tanks and Spills Section for closure. Further investigation at one of the UST sites, (UST No. 411), will be conducted by another contractor. The four sites investigated by OpTech during the SI are identified as: UST – Site No. 1, the former UST No. 591, adjacent to Building (BLDG) 659; UST – Site No. 2, the former UST No. 873, adjacent to BLDG 687; UST – Site No. 3, the former UST No. 801, adjacent to BLDG 680; and UST – Site No. 4, the former USTs No. 651/652, adjacent to former BLDG 665. These sites are shown on Figure 1.1.



SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995.

FIGURE 1.1

MINNEAPO\MINNBASE

LOCATIONS OF FORMER UST-SITES
1995 SITE INVESTIGATION
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

OPTECH
OPERATIONAL TECHNOLOGIES CORPORATION

JANUARY 1996

1.2 PURPOSE

The overall objective of the SI was to identify the presence or absence of petroleum hydrocarbon contamination at the former UST sites. This objective has been met through the SI activities. In addition, this SI Report provides specific information required to complete the Hazard Ranking System (HRS) "Data Requirements for Federal Facility Docket Sites" (Appendix H).

The specific objectives of the SI were to:

- Provide data to assist in determining the extent of petroleum hydrocarbon contamination;
- Obtain information to attempt to delineate the extent and magnitude of contamination on-site within the contracted Scope of Work specified by the ANGRC/CEVR;
- Identify subsurface conditions that could affect contaminant migration, containment, or cleanup; and
- Support site-specific decisions, such as no further action is warranted, prompt removal of contaminants is necessitated, or further investigative work is required.

1.3 SCOPE

The investigation of the subject sites at Minnesota ANGB included, but were not necessarily limited to, the following actions: determination and attempted quantification of soil and groundwater contamination from information obtained from a hydrogeologic investigation involving the installation of soil borings and monitoring wells; determination of hydraulic properties of water-bearing formations and an evaluation of groundwater flow direction; delineation of hydrogeologic conditions of the immediate study area, including the definition of subsurface soil types; and the determination of probable sources and potential receptors of detected contaminants. The results of this SI provide the technical basis to reach a decision point regarding the current status of each site.

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SECTION 2.0 FACILITY BACKGROUND INFORMATION

2.1 FACILITY DESCRIPTION

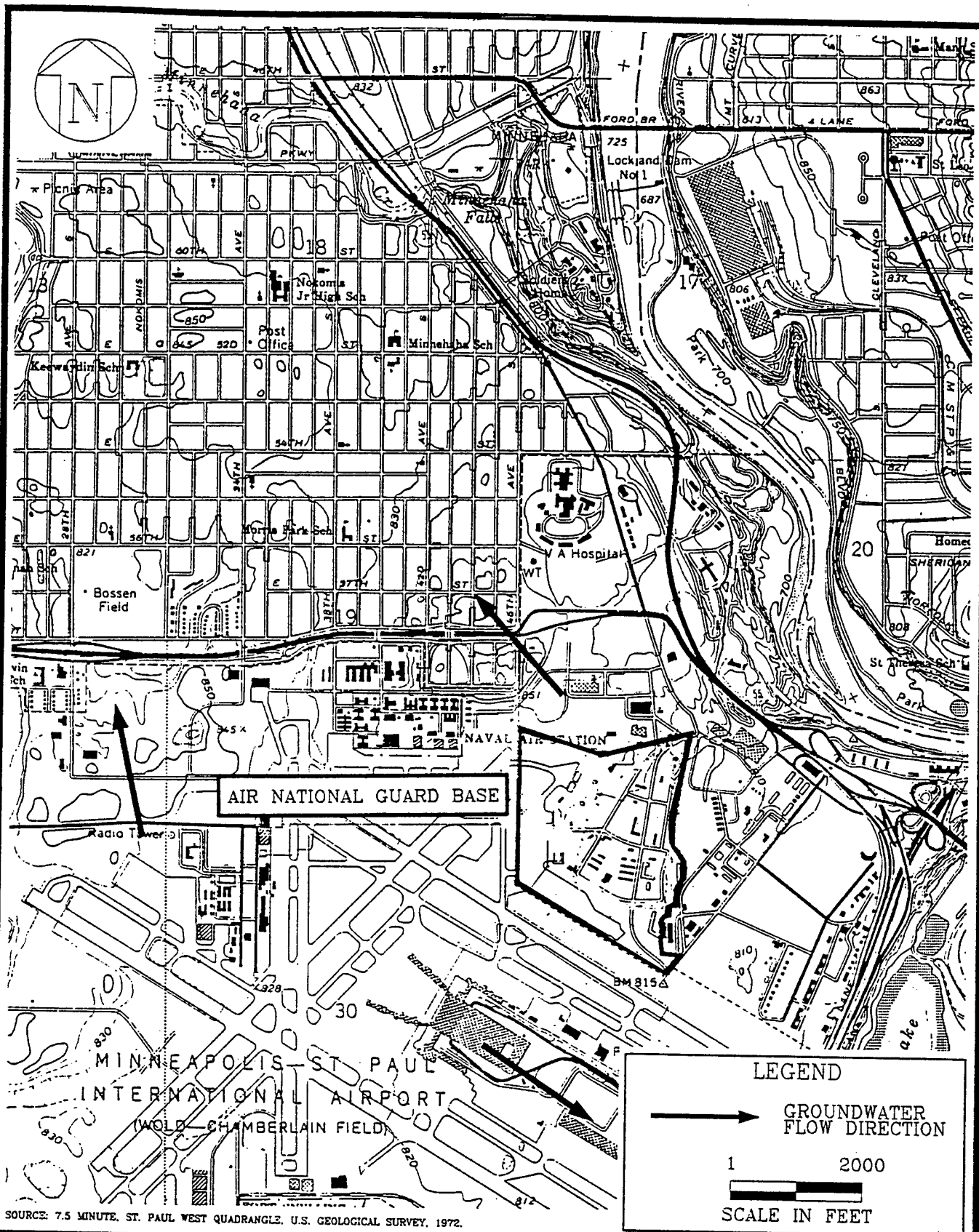
The Minnesota ANGB is located in the northeast portion of the Minneapolis-St. Paul International Airport (IAP) complex, in Hennepin County, approximately 8 miles southeast of downtown Minneapolis. The IAP complex is located near the confluence of the Minnesota and Mississippi Rivers and lies just south of the Minneapolis city limits (Figure 2.1). Within, and adjacent to, the IAP complex there are five separate United States Air Force (USAF) owned areas that comprise the Twin Cities Air Force Reserve Base (AFRB), which occupies approximately 284 acres. The host unit at the AFRB is the 934th Airlift Group of the Air Force Reserve. Minnesota ANGB is located in an area encompassing an estimated 147.3 acres. In addition to the Minnesota ANG, other tenants at the AFRB include a Marine Corps Reserve Unit, a Naval Air Reserve Center, and a Naval Reserve Readiness Command Unit.

Since 1951, the Twin Cities AFRB has been the home of the 133rd Tactical AW of the MNANG, which has a mission to provide command staff supervision of Tactical Airlift Groups. These groups provide the tactical airlift of airborne forces, equipment, and supplies and provide aeromedical evacuation.

2.1.1 Base History

The Minneapolis-St. Paul IAP was originally built in 1927 as Wold Chamberlain Field. An Air Force Flight Training Base was established at the Wold Chamberlain Field in 1943. Construction of some facilities began in 1944. In February 1952, the Air Defense Command assumed jurisdiction of the installation and initiated a construction program during 1953 and 1954 in the portion of the AFRB presently occupied by Minnesota ANGB. In January 1958, the Continental Air Command (now known as the Air Force Reserve) assumed jurisdiction of the base and the mission changed to reserve training. In 1969, the 934th Tactical Airlift Group became the AFRB host and assumed operational and support functions.

In 1957, Minnesota ANG moved to its present-day location. Two additional units attached to the 133rd Tactical AW include the 237th Flight Facilities Flight and the 210th Electronic Installations Squadron.



SOURCE: 7.5 MINUTE, ST. PAUL WEST QUADRANGLE, U.S. GEOLOGICAL SURVEY, 1972.

FIGURE 2.1

MINN\ST-PAUL

TOPOGRAPHIC MAP

133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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MAY 1998

2.1.2 Previous Environmental Investigations

Roy F. Weston, Inc. (Weston), conducted an Installation Restoration Program (IRP) Phase II – Confirmation/Quantification Study in 1984 (Weston, 1985) at the Minneapolis-St. Paul IAP, AFRB. The study was conducted for three sites, one (Suspected Petroleum Oil Lubricant (POL) Spill Area) of which was located on Minnesota ANGB property (see Figure 2.2). Based on these findings, a Remedial Investigation (RI) was initiated by the USAF which included two additional sites: the Motor Gasoline (MOGAS) Spill Area and the Battery Shop Leaching Pit. These two sites are also located on Minnesota ANGB property (Figure 2.2). The RI was conducted by Engineering-Science, Inc., in 1990.

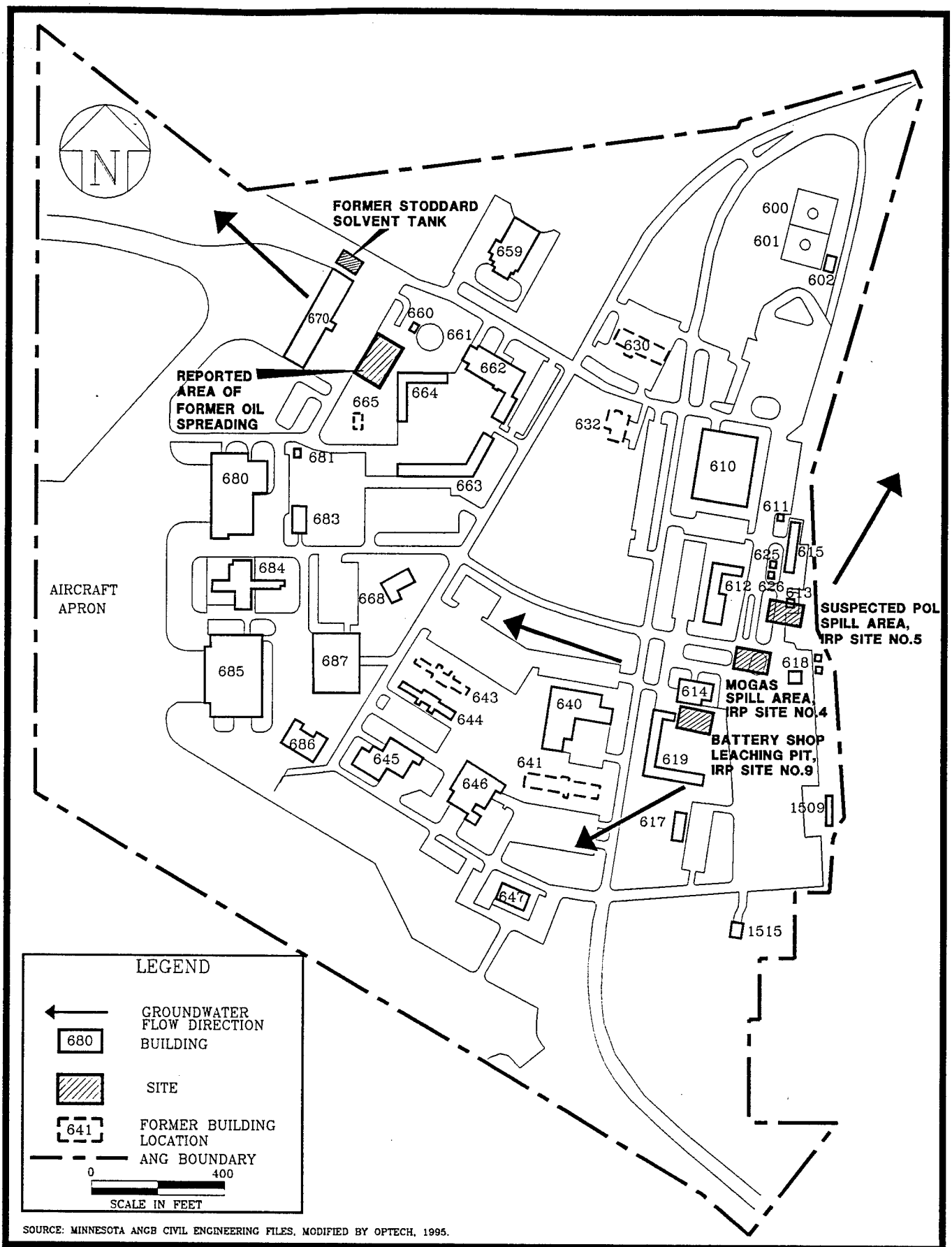
The three sites located at the Minnesota ANGB during Weston's Phase II Study are briefly described as follows:

- **The Suspected POL Spill Area,** IRP Site No. 5, was discovered during the removal of a 7,500-gallon heating oil storage railroad tank car, and minor POL product contamination was detected in the soil. Although no heating fuel spills have been or were reported, it is suspected that they may have occurred during routine fuel transfer activities. Another potential source could be from a reported spill on a railroad track which formerly ran through the site. The track was used for delivery of fuel to the tank farm in the area adjacent to this site. The groundwater flow direction at the site was determined to be easterly (Figure 2.2).

- **The MOGAS Spill Area,** IRP Site No. 4, was identified as the result of a 600-gallon MOGAS spill which reportedly occurred in 1958 or 1959 on the pavement near the old motor pool believed to be located east of Building 614. The groundwater flow direction was determined to be westerly (Figure 2.2).

- **The Battery Shop Leaching Pit,** IRP Site No. 9, was used prior to 1977 for the disposal of neutralized battery acid (Figure 2.2). Based on investigations conducted at Sites 4 and 5, located northeast of Site 9, groundwater movement appears to be to the west/southwest toward Site 9.

Based on data obtained during the previous investigations, a Feasibility Study (FS) was recommended to address groundwater contamination encountered at the POL and MOGAS sites. The Air Force Reserve authorized Braun Intertec Corporation to conduct additional field work to support the FS and to obtain additional data for remedial design. The field work was



SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995.

FIGURE 2.2

MINNEAPO\MINNBASE

LOCATIONS OF PREVIOUSLY INVESTIGATED SITES

133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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MAY 1996

conducted in the fall of 1993. An FS is currently in progress for the POL and MOGAS sites. Based on the results of the additional field investigation and revised risk assessment, a "no-action" alternative, with or without monitoring, is anticipated to be the recommended remedial action alternative (Braun Intertec, 1994).

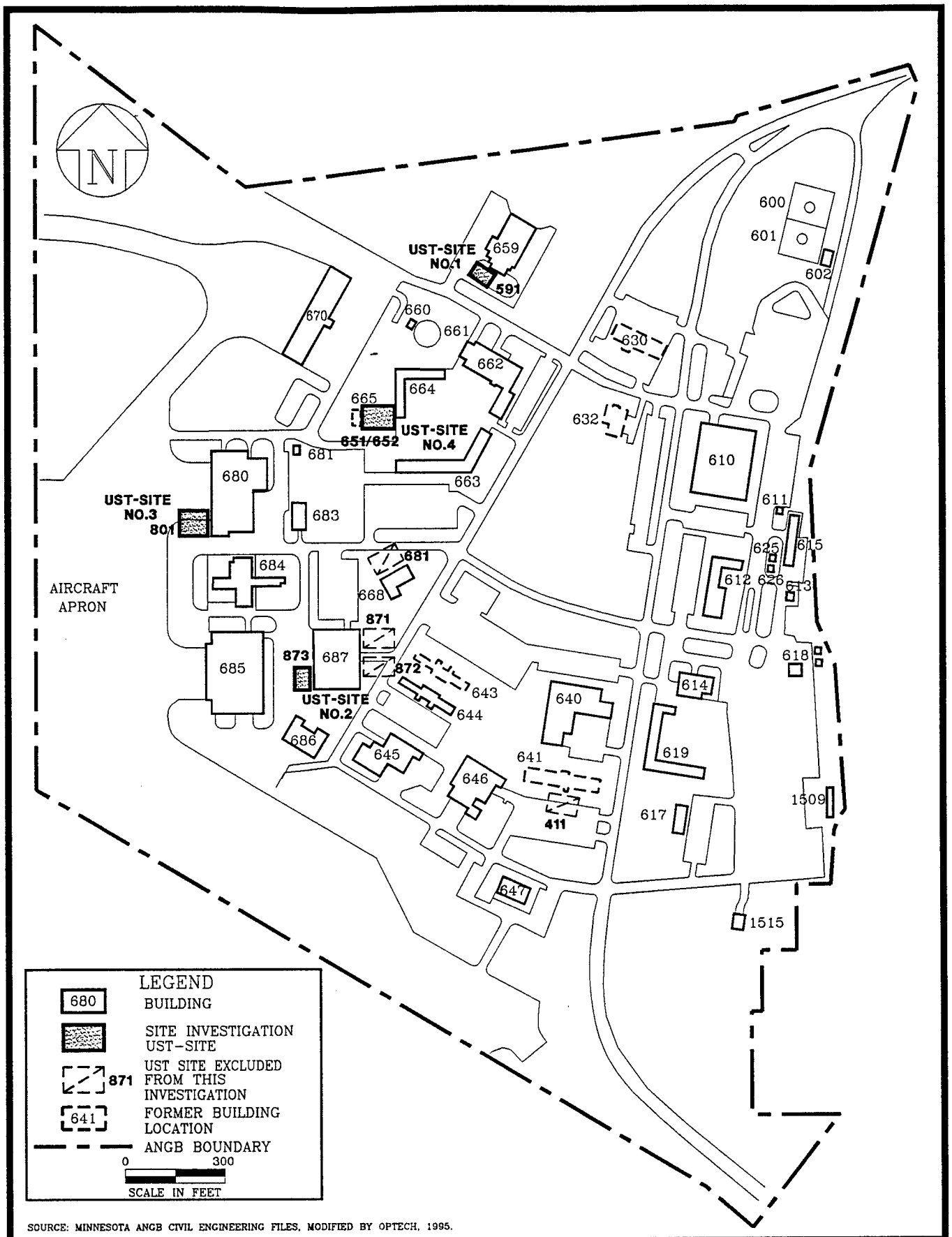
A suspected Stoddard solvent and waste oil spill investigation was conducted at the north end of the ANG Museum Hangar (Former C-97 Aircraft Hangar) by Barr Engineering Company (BEC) in 1992 (see Figure 2.2). Occasional Stoddard solvent releases occurred at two 250-gallon aboveground storage tanks over an approximate 10-year period, while used oil was occasionally spread for dust control across an unpaved automobile parking area during the same period. No evidence of soil contamination was discovered in borings placed in the vicinity of the former Stoddard solvent tanks. Soil staining by apparent hydrocarbons was visually identified in a thin zone underlying the reported oil spreading area; however, analytical and field screening results did not confirm the presence of soil contamination.

Groundwater samples were collected and analyzed from four monitoring wells installed near the sites. Benzene was detected in groundwater samples collected from these wells installed in the Platteville Aquifer at concentrations exceeding the Minnesota Recommended Allowable Limits (RALs). However, the investigation concluded that this contamination was not the result of the former Stoddard solvent tanks and the oil spreading activities. The suspected contaminant source identified by the BEC investigation was USTs No. 651/652, or UST - Site No. 4 of the current SI. The groundwater flow direction at the site was determined to be to the west and northwest.

In 1993, soil sampling was conducted by Bay West, Inc. during the removal of nine USTs, the locations of which are shown on Figure 2.3. Specific information pertaining to the sites which are the subject of this investigation has been included in the history of site activities for the individual sites in Section 2.2. Figure 2.4 shows the location of the UST sites under investigation relative to previously investigated UST sites.

2.2 SITE DESCRIPTIONS

Bay West, Inc., from St. Paul, Minnesota, was the general contractor for the removal of nine USTs from seven different sites at the Minnesota ANGB in July-August 1993. Seven of the nine USTs had failed tank tightness tests. Four of the seven sites are the subject of this investigation. Soil and water samples collected for laboratory analysis were sent to Bay West Analytical Laboratory. Samples, with the exception of samples collected from UST No. 873 (addressed in Subsection 2.2.2.1), were analyzed for benzene, toluene, ethylbenzene, and xylene isomers



SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995.

FIGURE 2.3

MINNEAPO\MINNBASE

LOCATIONS OF NINE REMOVED USTs

133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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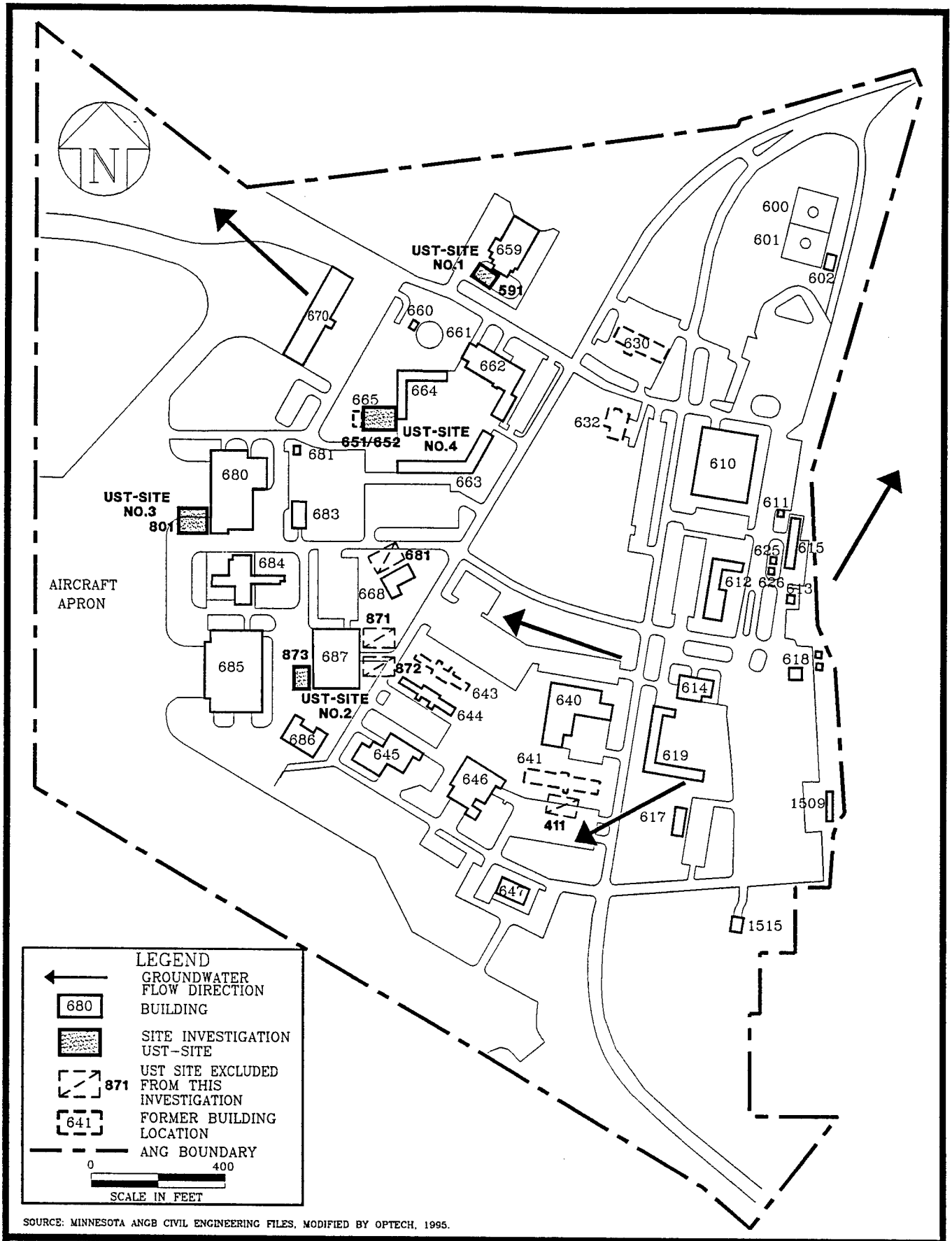

SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995.

FIGURE 2.4

MINNEAPO\MINNBASE

LOCATIONS OF UST SITES UNDER INVESTIGATION AND PREVIOUSLY INVESTIGATED UST SITES
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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(BTEX) by United States Environmental Protection Agency (USEPA) Method 8020 modified, and total petroleum hydrocarbons as diesel range organics (TPH-DRO) by Wisconsin Department of Natural Resources (WDNR) modified method. Sampling results from Bay West's investigation are presented in the history of site activities for the individual sites.

2.2.1 UST – Site No. 1, Former UST No. 591

This site is located in the north central portion of the base (Figure 2.4). A 2,000-gallon steel UST, used to store No. 2 fuel oil, was formerly located approximately 20 feet from the southwest corner of Bldg. 659, the Air Logistics Center (Figure 2.5). The UST was installed in 1975 and removed in August 1993 (Bay West, 1993).

The site is grass-covered. Underground utilities in the vicinity of the site are shown on Figure 2.5.

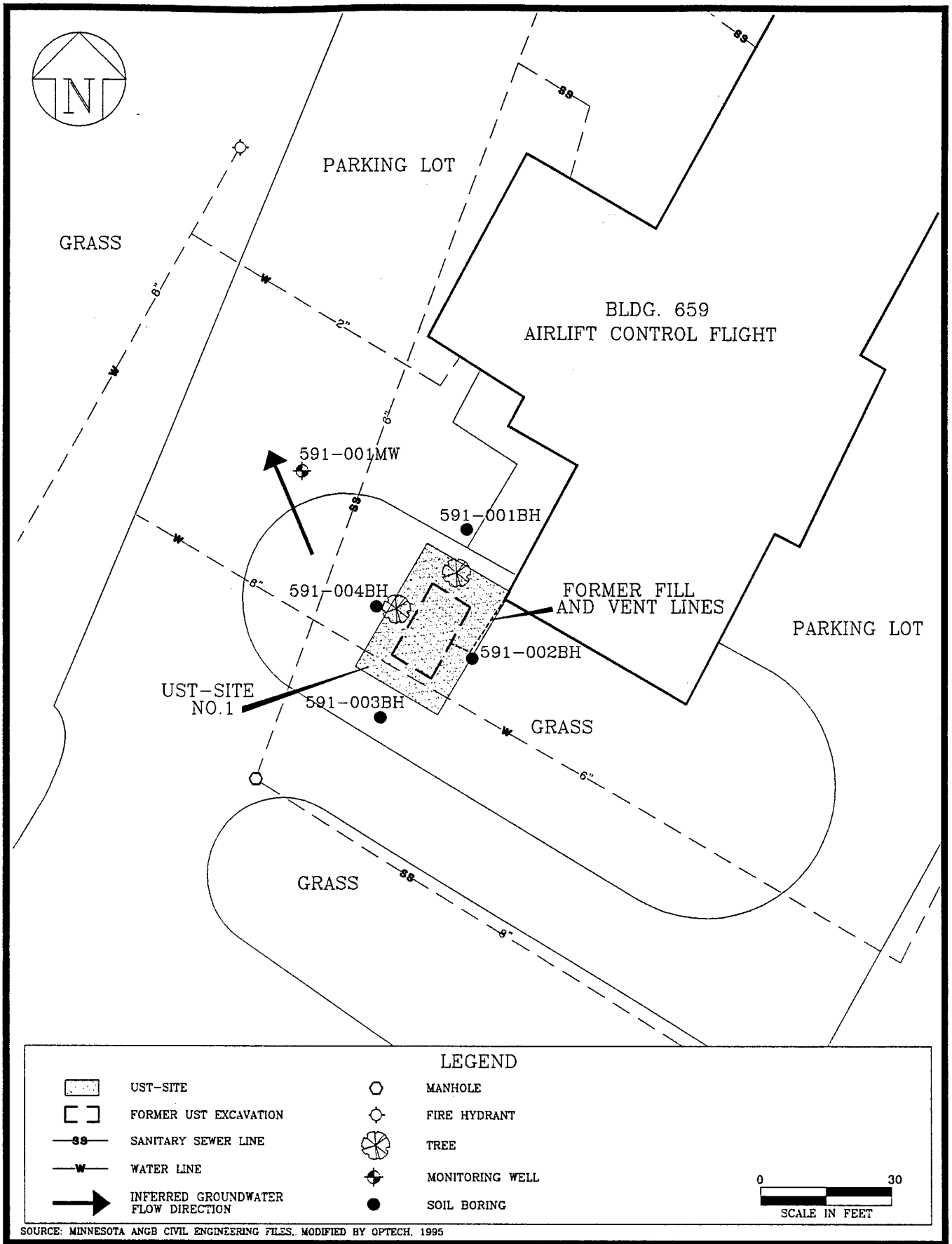
2.2.1.1 History of Site Activities

UST No. 591, along with associated piping, was removed on 24 August 1993. According to Bay West, the size of the excavation measured approximately 10 feet wide, 20 feet long, and 10 feet deep. Groundwater was encountered in the excavation. On the same date, eight soil samples were collected from the excavation for headspace analysis using an organic vapor monitor (OVM). Also, three samples (two from the tank pit bottom, and one at the piping elbow) were collected for laboratory analysis. Sampling locations are shown on Figure 2.6.

Headspace analysis detected organic volatiles in two soil samples, SV-5 collected from a depth of 10.0 feet BLS, and SV-7 collected from a depth of 2.0 feet BLS. Organic volatiles were detected at concentrations of 80 parts per million (ppm) and 0.8 ppm in samples SV-5 and SV-7, respectively.

Soil samples were analyzed for BTEX and TPH-DRO. BTEX was not detected in any of the three soil samples submitted for analysis. TPH-DRO was detected at concentrations of 280 milligrams per kilogram (mg/kg) in sample SS-3 collected from a depth of 2.0 feet BLS, and at 1,300 mg/kg in sample SS-1 collected from a depth of 8.0 feet BLS.

After soil sampling was completed, the excavation was lined with plastic and backfilled with clean sand. Leak No. 6686 has been assigned to this site by MPCA.



SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES. MODIFIED BY OPTECH. 1995

FIGURE 2.5

MINN\SITE

UST-SITE NO.1
(FORMER UST NO.591)
SITE PLAN
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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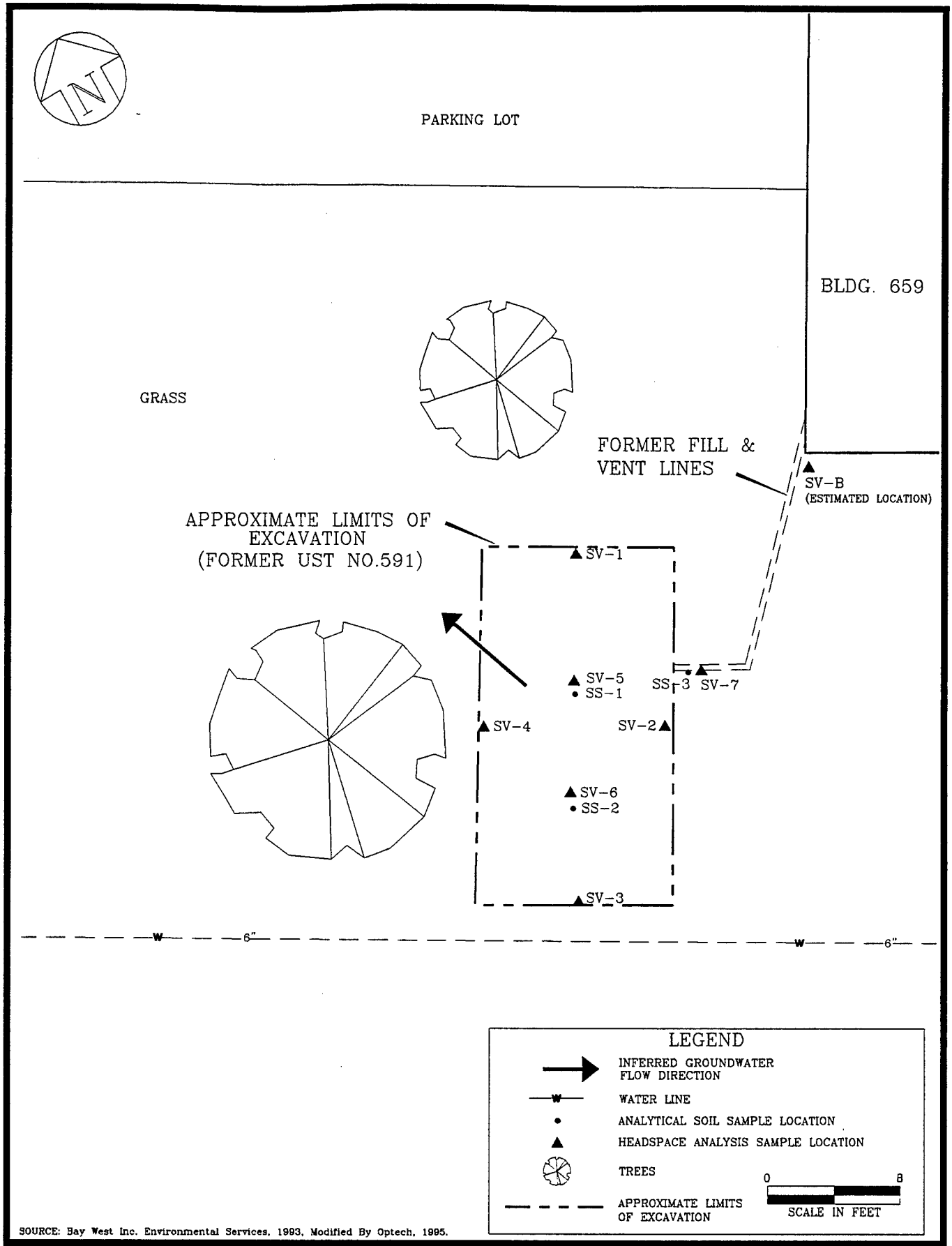

SOURCE: Bay West Inc. Environmental Services, 1993, Modified By Optech, 1995.

FIGURE 2.6

MINN\SAMP3-5

SAMPLE LOCATIONS AT
UST-SITE NO.1 EXCAVATION
BAY WEST INC. INVESTIGATION,
AUGUST 1993
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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2.2.2 UST – Site No. 2, Former UST No. 873

This site is located near the center of the base, adjacent to Bldg. 687 (Figure 2.3). A 1,000-gallon steel UST, used as an oil/water separator and to store waste oil, was formerly located adjacent to the southwest corner of Bldg. 687, the Field Maintenance Shop (Figure 2.7). The former location of another UST, used to store diesel fuel, is located approximately 60 feet south of the site. The date of installation is unknown. The UST was removed in August 1993 (Bay West, 1993).

The site is paved with asphalt. Underground utilities in the vicinity of the site are shown on Figure 2.7.

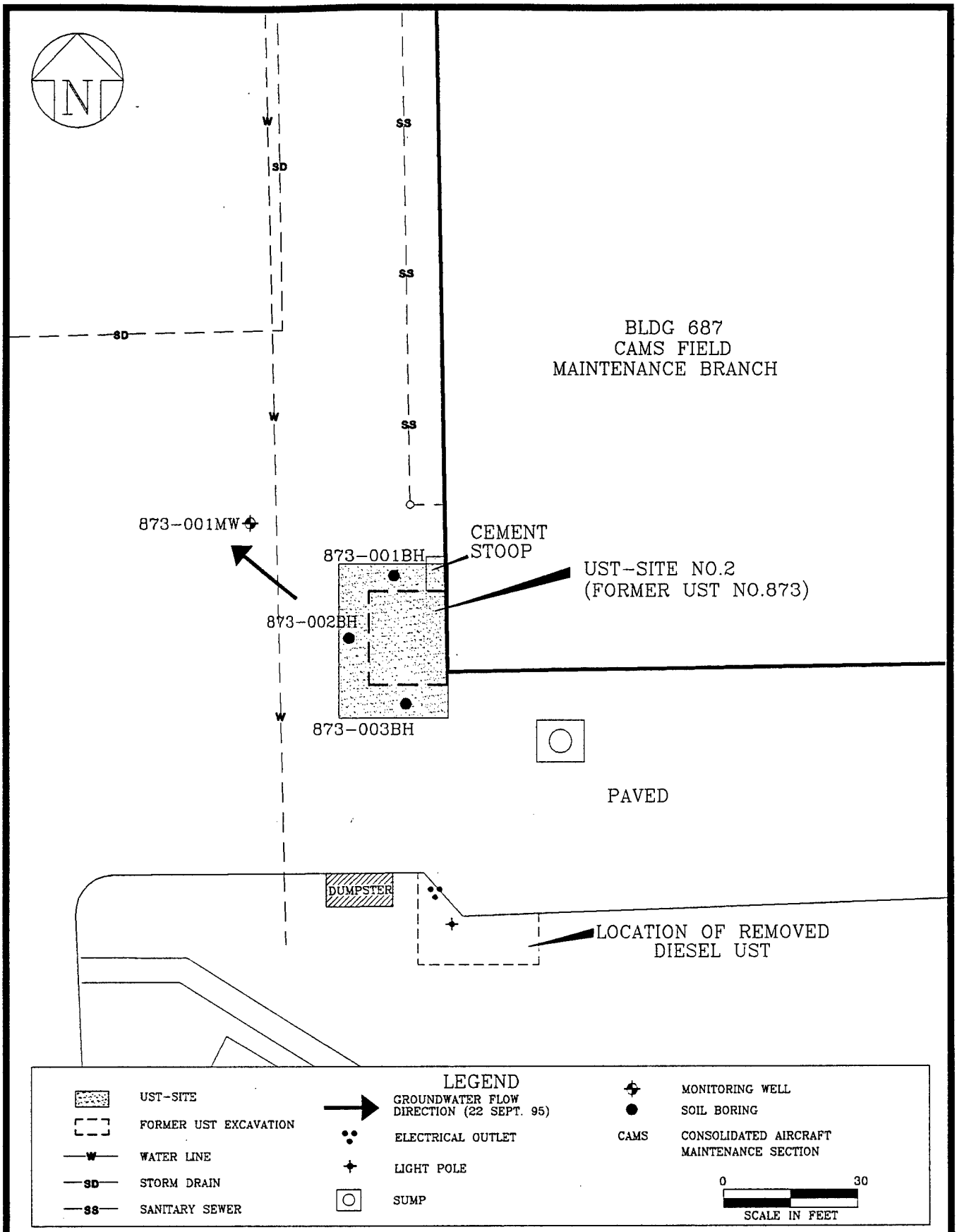
2.2.2.1 History of Site Activities

The UST No. 873, along with associated piping, was removed on 26 August 1993. According to Bay West, the size of the excavation measured approximately 17 feet wide, 18 feet long, and 7 feet deep. Approximately 72 cubic yards of contaminated soil were removed. Groundwater was not encountered in the excavation. On 30 August 1993, eight soil samples were collected from the excavation for headspace analysis, using an OVM, and two soil samples and one waste oil/water sample were collected for laboratory analysis. Soil sampling locations are shown on Figure 2.8.

Headspace analysis detected organic volatiles at concentrations of 0.4 ppm and 1.0 ppm in soil vapor samples SV-1 and SV-4, respectively. Sample SV-1 had been collected from a depth of 7.0 feet BLS, and SV-4 from a depth of 2.0 feet BLS.

Soil samples and the waste oil/water sample were analyzed for arsenic, barium, cadmium, chromium, lead, selenium, and silver by USEPA Method SW6010, and mercury by USEPA Method SW7470/SW7471; purgeable halogenated and non-halogenated compounds Minnesota Department of Health (MDH) 465D Target Compound List by MDH 465 modified; TPH-DRO by WDNR Modified; and polychlorinated biphenyls (PCBs) by USEPA SW8080 modified.

Barium was detected at a concentration of 25.4 mg/kg, chromium at 16.0 mg/kg, and lead at 8.7 mg/kg in soil sample SS-1 collected from a depth of 7.0 feet BLS. TPH-DRO was also detected in the same sample at a concentration of 24 mg/kg. No purgeable halogenated and non-halogenated compounds or PCBs were detected in soil samples.



SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995.

FIGURE 2.7

MINN\SITE-873

UST-SITE NO.2
(FORMER UST NO.873) SITE PLAN
BAY WEST INC. INVESTIGATION,
AUGUST 1993
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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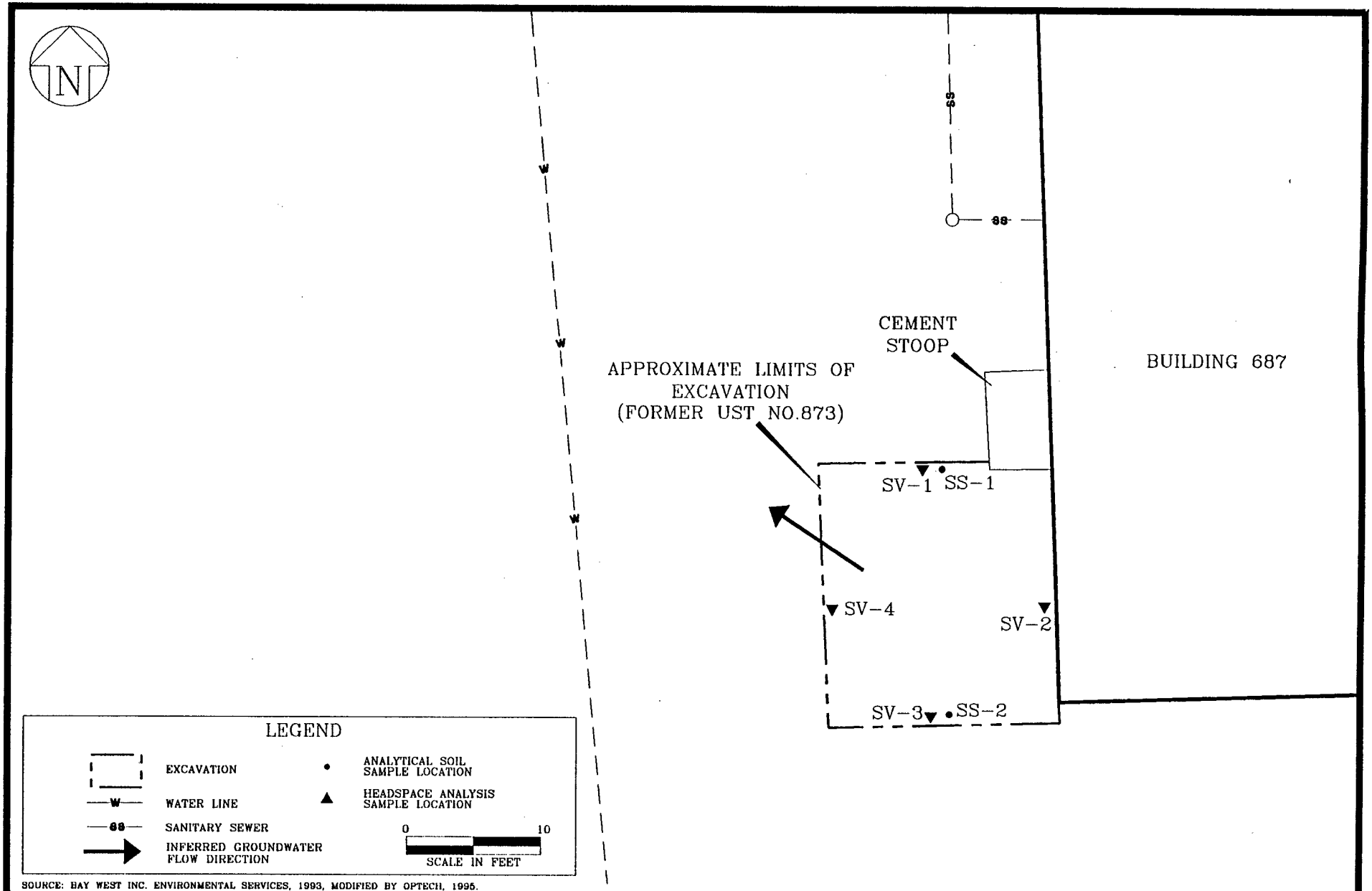
JANUARY 1996



SOURCE: BAY WEST INC. ENVIRONMENTAL SERVICES, 1993, MODIFIED BY OPTECH, 1995.

FIGURE 2.8

MINN\873-EXC

SAMPLE LOCATIONS AT UST-SITE NO.2 EXCAVATION
BAY WEST INC. INVESTIGATION, AUGUST 1993
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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Barium, chromium, TPH-DRO, and a variety of volatile organic compounds (VOCs) were detected in the waste oil water sample. Analytical results of the waste oil water sample are presented in Table 2.1.

Table 2.1
Analytes Detected in the Waste Oil Water Sample
UST – Site No. 2, Former UST No. 873, August 1993
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

Parameter	Waste Oil/Water Sample
Barium (mg/L)	0.279
Chromium (mg/L)	0.018
Butylbenzene, n- (μg/L)	32
Butylbenzene, sec- (μg/L)	9.7
Butylbenzene, tert- (μg/L)	2.0
Ethylbenzene (μg/L)	22
Isopropylbenzene (μg/L)	10
Isopropyltoluene, p- (μg/L)	6.3
Methylene Chloride (μg/L)	43
Naphthalene (μg/L)	11
Propylbenzene, n- (μg/L)	18
Toluene (μg/L)	460
Trimethylbenzene 1,2,4- (μg/L)	140
Trimethylbenzene 1,3,5- (μg/L)	20
Xylene m,p- (μg/L)	320
Xylene o- (μg/L)	110
TPH-DRO (μg/L)	450

mg/L – milligrams per liter.
μg/L – micrograms per liter.
Source: Bay West, 1993.

TPH-DRO – Total Petroleum Hydrocarbons- Diesel Range Organics.

After sampling was completed, the excavation was lined with plastic and backfilled with clean sand. Leak No. 6685 has been assigned to the site by MPCA.

2.2.3 UST – Site No. 3, Former UST No. 801

This site is located on the west half of the base adjacent to Bldg. 680 (Figure 2.3). A 20,000-gallon steel UST, used to store No. 2 fuel oil, was formerly located adjacent to the southwest corner of the Northern Aircraft Hangar, Bldg. 680 (Figure 2.9). The UST was installed in 1956 and removed in August 1993 (Bay West, 1993).

The site is paved with asphalt. Underground utilities in the vicinity of the site are shown on Figure 2.9.

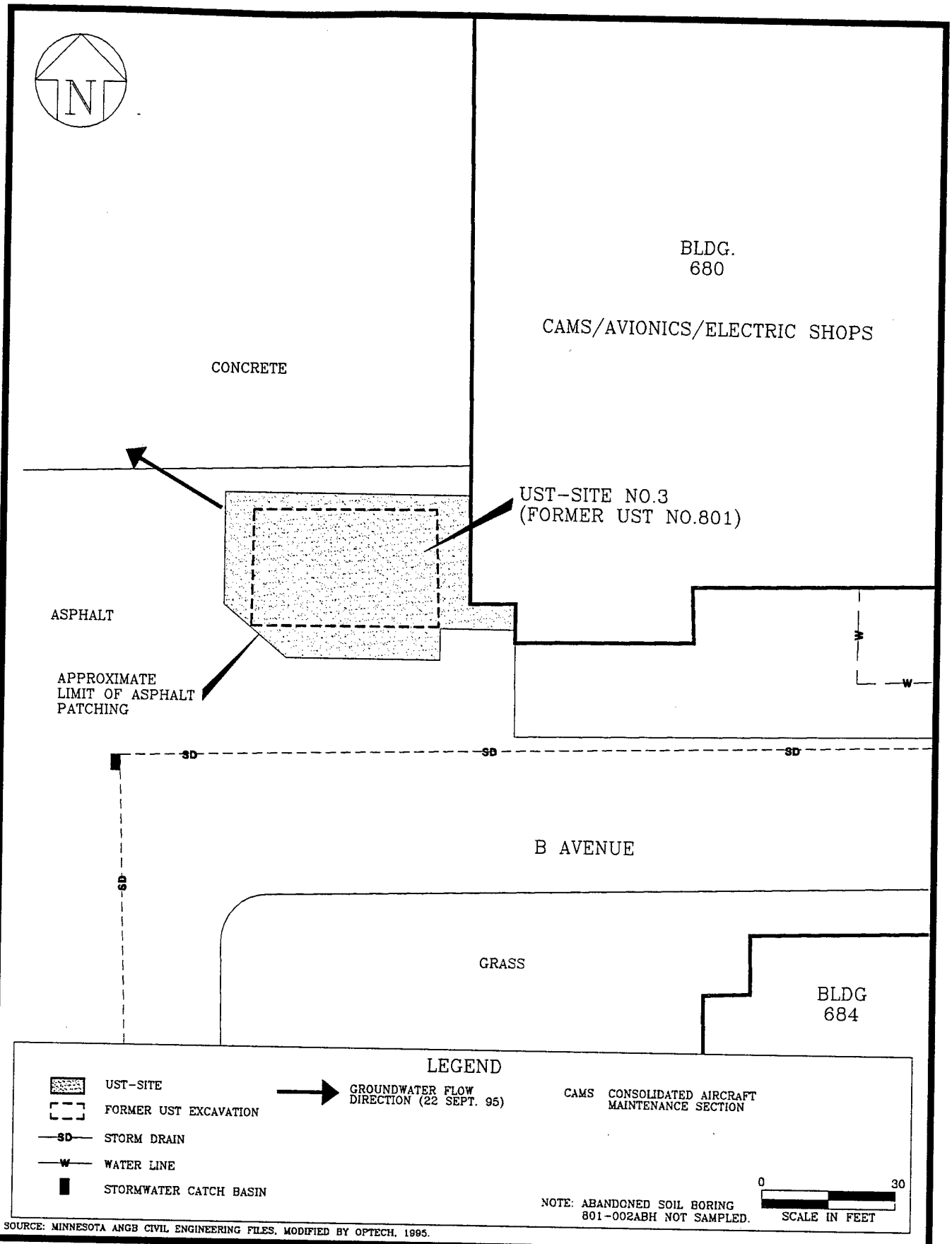

FIGURE 2.9

MINN\SITE-801

UST-SITE NO.3
(FORMER UST NO.801) SITE PLAN
BAY WEST INC. INVESTIGATION,
AUGUST 1993
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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2.2.3.1 History of Site Activities

The UST No. 801, along with associated piping, was removed on 4-5 August 1993. According to Bay West, the size of the excavation measured approximately 25 feet wide, 36 feet long, and 13 feet deep. Approximately 127 cubic yards of contaminated soil were removed. Groundwater was encountered in the excavation. On 6 August 1993, 12 soil samples were collected from the excavation for headspace analysis, using an OVM, and four samples were collected for laboratory analysis. Sampling locations are shown on Figure 2.10.

Headspace analysis detected organic volatiles in all 12 soil samples. The OVM readings are presented in Table 2.2.

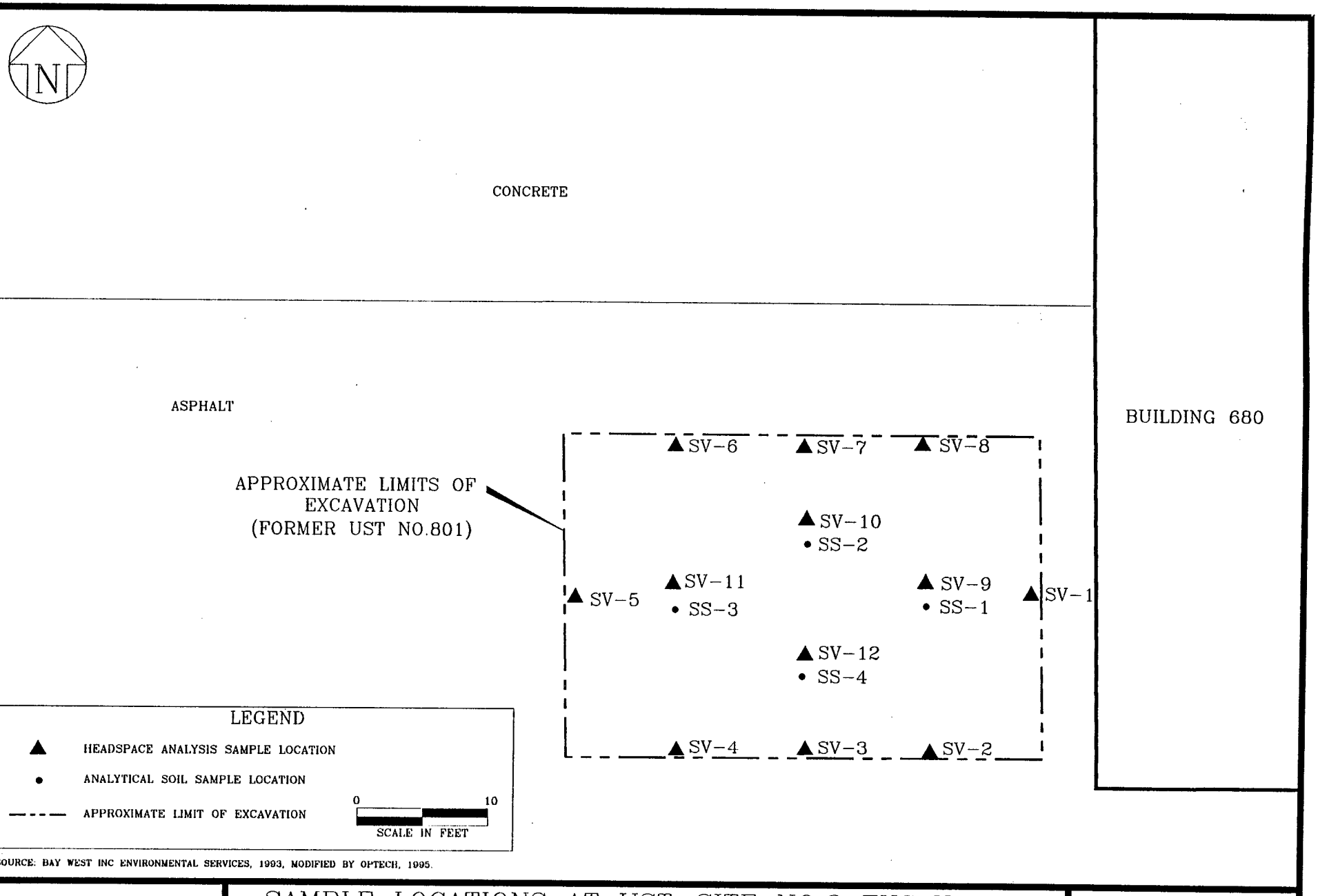
Table 2.2
OVM Screening Data for Soil Samples Collected from
UST – Site No. 3, Former UST No. 801 Excavation, August 1993
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

Soil Vapor Sample	Depth (feet BLS)	OVM Reading (ppm)
SV-1	7.0	47
SV-2	7.0	86
SV-3	7.0	95
SV-4	7.0	52
SV-5	7.0	16
SV-6	7.0	40
SV-7	7.0	66
SV-8	7.0	81
SV-9	13.0	91
SV-10	13.0	52
SV-11	13.0	106
SV-12	13.0	87

BLS – Below Land Surface.
OVM – Organic Vapor Monitor.
SV – Soil Vapor Sample.
ppm – parts per million.
Source: Bay West, 1993.

Soil samples were analyzed for BTEX and TPH-DRO. Soil samples collected from the excavation floor at a depth of 13.0 feet BLS exhibited BTEX and high levels of TPH-DRO (Table 2.3).

A water sample collected on 6 August 1993 was analyzed for BTEX and TPH-DRO. Benzene was detected at a concentration of 13 micrograms per liter (μg/L), toluene at 16 μg/L, ethylbenzene at 34 μg/L, and xylene at 140 μg/L. TPH-DRO was detected at a concentration of 30,000 μg/L.



SOURCE: BAY WEST INC ENVIRONMENTAL SERVICES, 1993, MODIFIED BY OPTECH, 1995.

FIGURE 2.10

MINN\801-EXC

SAMPLE LOCATIONS AT UST-SITE NO.3 EXCAVATION
BAY WEST INC. INVESTIGATION, AUGUST 1993
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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Table 2.3
Soil Sample Results from
UST – Site No. 3, Former UST No. 801 Excavation, August 1993
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

Parameter	SS-1 (mg/kg)	SS-2 (mg/kg)	SS-3 (mg/kg)	SS-4 (mg/kg)
Benzene	ND	0.23	ND	ND
Toluene	ND	0.14	ND	ND
Ethylbenzene	3.2	0.47	ND	1.6
Xylene	14	1.6	1	6.1
TPH-DRO	12,000	2,000	880	3,900

SS/SV – Soil/Soil Vapor Sample.
ND – Not Detected.
Source: Bay West, 1993.
mg/kg – milligrams per kilogram.
TPH-DRO – Total Petroleum Hydrocarbons Diesel Range Organics.

After sampling was completed, the excavation was lined with plastic and backfilled with clean sand. Leak No. 6621 has been assigned to the site by the MPCA.

2.2.4 UST – Site No. 4, Former USTs No. 651/652

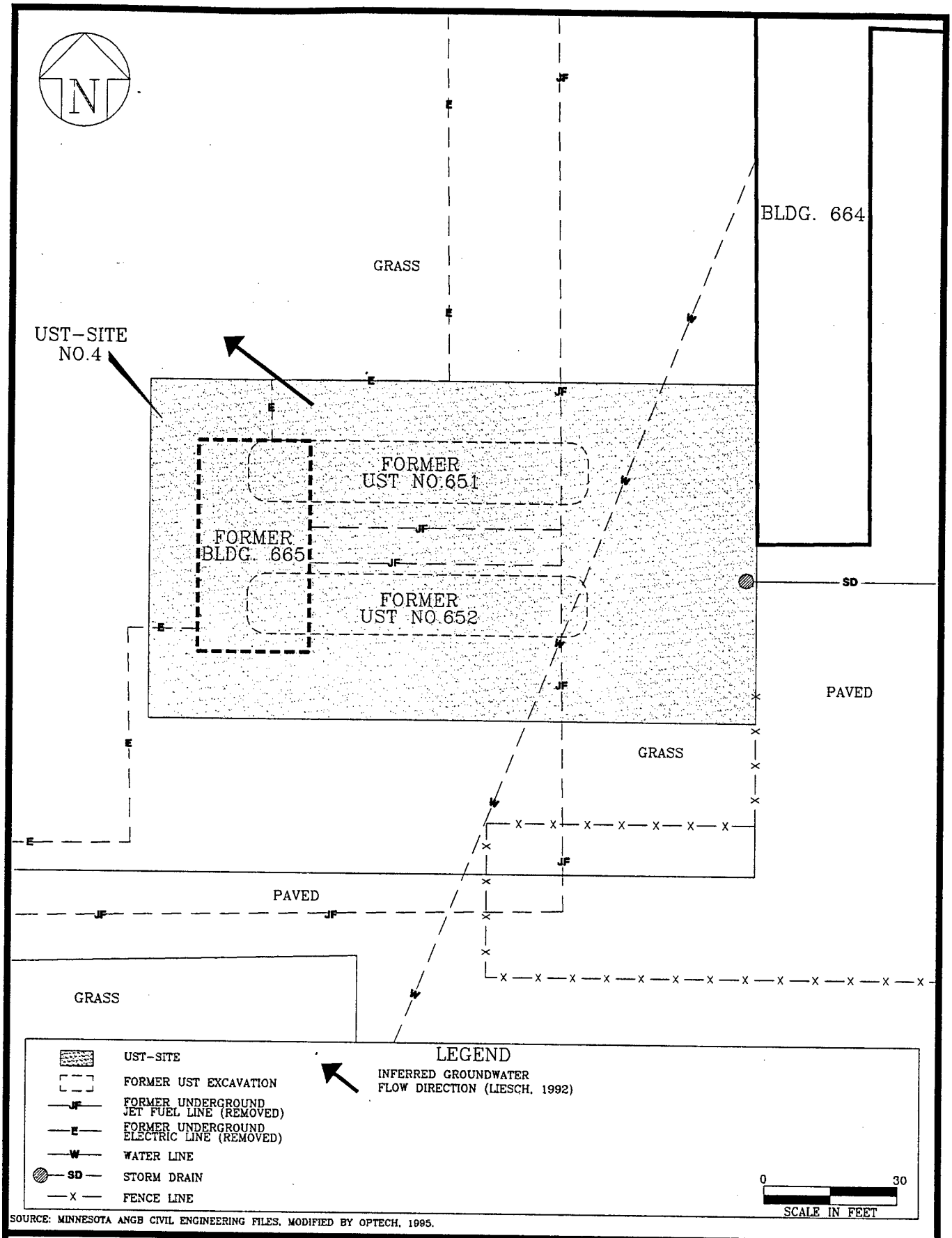
This site is located in the northwest portion of the base adjacent to former Bldg. 665 (Figure 2.3). Two 50,000-gallon steel USTs were formerly located beneath and to the east of the former Fuel Pumphouse, Bldg. 665 (Figure 2.11). The USTs were used to store No. 2 fuel oil; however, they had formerly been used to store AVGAS. Bldg. 665 was a fuel pump house and was demolished concurrently with the tank removals. The tanks were oriented in a west to east direction with UST No. 651 situated to the north of UST No. 652. The USTs were installed in 1953 and removed in July-August 1993 (Bay West, 1993).

The site is covered with grass. Underground utilities in the vicinity of the site are indicated on Figure 2.11.

Former USTs Nos. 651/652 were reported as the probable source of groundwater contamination detected in the Platteville Aquifer during field activities conducted by BEC in 1992 at the "former oil-spreading site" located upgradient of the former UST site.

2.2.4.1 History of Site Activities

The USTs No. 651/652, along with associated piping, were removed from 22 July to 5 August 1993. According to Bay West, the size of the excavation measured approximately 55 feet wide, 95 feet long, and 18 feet deep. Approximately 1,803 cubic yards of contaminated soil



SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995.

FIGURE 2.11

MINN\SITE652

UST-SITE NO.4
(FORMER USTs NO.651/652)
SITE PLAN
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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were removed. Groundwater was encountered in the excavation. On 4 August 1993, 20 soil samples were collected from the excavation for headspace analysis, using an OVM, and six samples were collected for laboratory analysis. Sampling locations are shown on Figure 2.12. Headspace analysis detected organic volatiles in all 20 soil samples. The OVM readings are presented in Table 2.4.

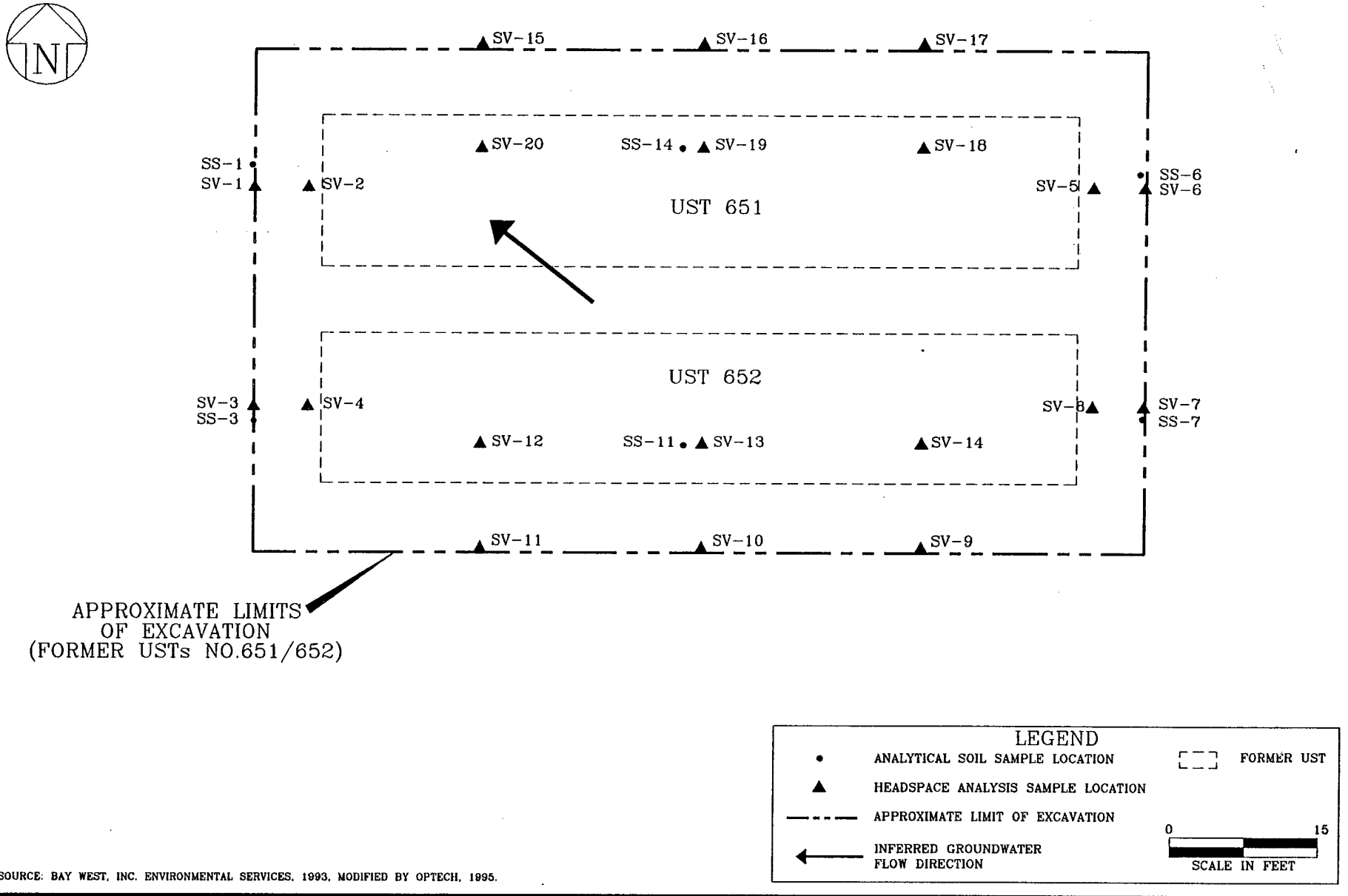
Table 2.4
OVM Screening Data for Soil Samples Collected from
UST – Site No. 4, Former USTs No. 651/652 Excavation, August 1993
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

Soil Vapor Sample	Depth (feet BLS)	OVM Reading (ppm)
SV-1	8.0	203
SV-2	16.0	102
SV-3	8.0	114
SV-4	16.0	117
SV-5	16.0	228
SV-6	8.0	296
SV-7	8.0	101
SV-8	16.0	230
SV-9	8.0	177
SV-10	8.0	247
SV-11	8.0	144
SV-12	16.0	230
SV-13	16.0	203
SV-14	16.0	247
SV-15	8.0	57
SV-16	8.0	66
SV-17	8.0	8
SV-18	16.0	185
SV-19	16.0	158
SV-20	16.0	237

BLS – Below Land Surface.
OVM – Organic Vapor Monitor.
Source: Bay West, 1993.
SV – Soil Vapor Sample.
ppm – parts per million.

Soil samples were analyzed for BTEX and TPH-DRO. Soil samples SS-1, SS-3, SS-6, and SS-7 were collected from the excavation sidewalls at a depth of 8.0 feet BLS. Soil samples SS-11 and SS-14 were collected from the excavation floor at a depth of 16.0 feet BLS. Sample results are presented in Table 2.5.

A water sample collected from the excavation on 29 July 1993 was analyzed for BTEX. Benzene was detected at a concentration of 61 μg/L, toluene at 51 μg/L, ethylbenzene at 140 μg/L, and xylene at 750 μg/L.



SOURCE: BAY WEST, INC. ENVIRONMENTAL SERVICES, 1993, MODIFIED BY OPTECH, 1995.

FIGURE 2.12

MINN\UST-EXC

SAMPLE LOCATIONS AT UST-SITE NO.4 EXCAVATION
BAY WEST INC. INVESTIGATION, AUGUST 1993
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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Table 2.5
Soil Sample Results from
UST – Site No. 4, Former USTs No. 651/652 Excavation, August 1993
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

Parameter	SS-1 (mg/kg)	SS-3 (mg/kg)	SS-6 (mg/kg)	SS-7 (mg/kg)	SS-11 (mg/kg)	SS-14 (mg/kg)
Benzene	ND	ND	ND	ND	ND	ND
Toluene	0.05	0.05	2.1	ND	0.46	ND
Ethylbenzene	ND	ND	1.5	ND	0.47	ND
Xylene	0.07	ND	4.9	ND	7.2	ND
TPH-DRO	840	610	590	150	300	220

SS – Soil Sample.
ND – Not Detected.
Source: Bay West, 1993.
mg/kg – milligrams per kilogram.
TPH-DRO – Total Petroleum Hydrocarbons- Diesel Range Organics.

A water sample collected on 4 August 1993 was analyzed for BTEX and TPH-DRO. Benzene was detected at a concentration of 74 μg/L, toluene at 400 μg/L, ethylbenzene at 220 μg/L, and xylene at 1,200 μg/L. TPH-DRO was detected at a concentration of 1,900 μg/L. After sampling was completed, the excavation was lined with plastic and backfilled with clean sand. Leak No. 6580 has been assigned to the site by the MPCA.

SECTION 3.0 ENVIRONMENTAL SETTING

3.1 ENVIRONMENTAL SETTING

3.1.1 Physiography and Climate

The Minnesota ANGB is located in the northeast portion of the Minneapolis-St. Paul IAP complex, in Hennepin County. The IAP complex is located near the confluence of the Minnesota and Mississippi Rivers. The Minneapolis-St. Paul IAP is comprised of two distinct topographic areas, a flat to gently sloping upland and a narrow lowland adjacent to the rivers. These two areas are separated by an approximate 60- to 80-foot high vertical escarpment. The upland area slopes gently downward to the east toward the Mississippi River from a maximum elevation of about 860 feet above mean sea level (MSL) in the northern and northwestern portions of the airport to an elevation of approximately 800 feet above MSL along the top of the escarpment. The lowland is situated at an elevation of about 730 to 740 feet MSL at the base of the escarpment, and an elevation of about 690 feet above MSL at the river. The width of the lowland from the base of the escarpment to the river varies from about 600 to 2,500 feet. Minnesota ANGB is located on relatively flat terrain with a surface elevation of approximately 820 feet above MSL (see Figure 2.1) (Weston, 1985).

The climate of Minnesota is classified as predominately continental. Average daily temperatures range from 20° F in the winter to 65° F in the summer. Minnesota's winters are cold with a maximum daily temperature remaining below freezing for an average of 108 days per year. The average date of the autumn killing frost is October 13 (National Climatic Data Center, December 1994). The mean annual snowfall is 76.9 inches, and the greatest snow depth record is 121 inches, which occurred during the winter of 1968-69. The mean annual precipitation is 25.94 inches. Approximately 65 percent of the annual precipitation (16.86 inches) occurs during the growing season from May through September. The winter precipitation is dominated by snow flurries while summer precipitation usually occurs as showers or thundershowers.

3.1.2 Geology

3.1.2.1 Regional Geology

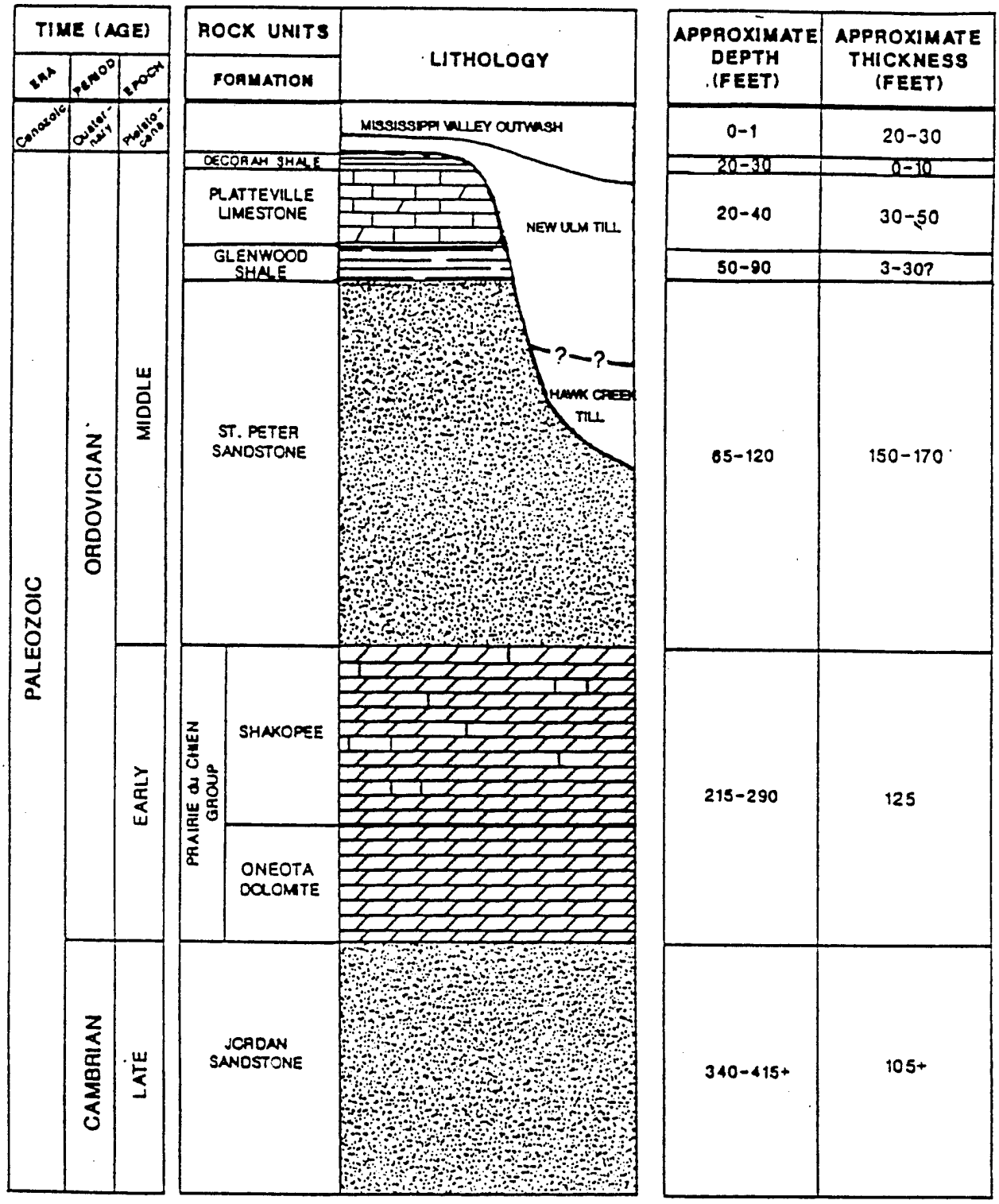
The geologic setting of Minneapolis-St. Paul (also referred to as the Twin Cities) on a regional scale is characterized by a thick sequence of sedimentary bedrock units overlain by unconsolidated glacial deposits and more recent alluvium all confined within the Twin Cities

Basin (Mossler, 1972). A generalized stratigraphic column for the specific IAP complex and near vicinity is presented in Figure 3.1 (Weston, 1985; CH2M Hill, 1993; and Liesch, 1992). Table 3.1 provides a general description of each unit and a summary of the water-bearing characteristics within the Twin Cities Basin.

The bedrock formations of the Twin Cities area are composed of early Paleozoic marine sedimentary rocks which form the uppermost bedrock in a unique local geologic structure referred to as the Twin Cities Basin (Mossler, 1972). As much as 1,000 feet of sedimentary rocks occur in this basin structure, which was formed as a small structural and depositional basin along the northeastern margin of the much larger Hollandale Embayment. This small basin is roughly elliptical in shape with a northeastern strike for the long axis. The structural trend of the Twin City Basin is best illustrated by the easily identifiable contact between the top of the Jordan Sandstone (late Cambrian) and the base of the Prairie du Chien Group (early Ordovician) because this contact is stratigraphically conformable and widespread. The margins of the Twin City Basin are comprised of a variety of geologic features, including the Belle Plaine Fault along the southern margin, the Vermillion and Hudson-Afton Anticlines along the eastern margin, and depositional on-lap of younger sediments and structural movement along the northern margin (Figure 3.2).

The Paleozoic bedrock is blanketed by varying thicknesses of unconsolidated sediments deposited as a result of the last glaciation, the late Wisconsin (about 25,000 to 10,000 year ago). Older Wisconsin glacial sediments have also been identified in the Twin Cities, although these deposits are relatively minor and occur at depth. The late Wisconsin glacial activity in the Twin Cities area involved the complete inundation of the region by continental glaciers spawned from two geologically distinctive areas in Canada. The earlier Superior glacial lobe originated in the Labradorean region north and east of Lake Superior, and the later Des Moines lobe was spawned in the Keewatin region north and west of the Twin Cities. The presence of each of the late Wisconsin ice sheets is evidenced by the differing sediment types carried by the two glaciers.

Glacial deposition and meltwater erosion during the advance and retreat of the Superior and Des Moines lobes produced a relatively flat landscape of glacial till, outwash plains, and ice-contact deposits with a fairly simple drainage pattern with two large bedrock valleys. Underlying the present landscape is a buried bedrock surface exhibiting a well-developed dendritic steam pattern that may pre-date the late Wisconsin glacial period. This system of buried valleys is interpreted from geologic logs from water well and soil boring records, and is found to have buried river valleys of the same magnitude, or even greater relief, than the present-day system. Boring logs at and near the Minneapolis-St. Paul IAP indicate a large



SOURCE: MODIFIED FROM PHASE II IRP REPORT, WESTON, 1985; CH2M HILL, 1983

FIGURE 3.1

MINN/GENLSTRT

GENERALIZED STRATIGRAPHIC COLUMN FOR MINNEAPOLIS-ST. PAUL IAP
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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DECEMBER 1995

Table 3.1
Regional Geologic Units and Their Water-Bearing Characteristics
Twin Cities Basin, Minnesota

System	Geologic Unit	Approximate Range in Thickness (in feet)	Description	Water-Bearing Characteristics
Quaternary	Undifferentiated Glacial Drift	0-400+	Glacial till, outwash sand and gravel, valley train sand gravel, lake deposits, and alluvium of several ages and several provenances; vertical and horizontal distribution of units is complex.	Distribution of aquifers and relatively impermeable confining beds is poorly known. Where saturated, stratified well-sorted deposits of sand and gravel (alluvium, valley train, outwash, some lake and ice-contact deposits) yield moderate to large supplies of water to wells. Records of 24 large diameter wells completed in sand and gravel show yields ranging from 240 to 2,000 gpm (gallons per minute) with from 2 to 69 feet of drawdown. Des Moines Lobe till is non-water-bearing; Superior Lobe till is sandy and may yield small supplies suitable for domestic or farm use.
Ordovician	Decorah Shale	0-95	Unconformity. Shale, bluish-green to bluish-gray; blocky; thin, discontinuous beds of fossiliferous limestone throughout formation.	Only about 25 square miles in extent in area of study. Confining bed.
	Platteville	0-35	Dolomitic limestone and dolomite, dark gray hard, thin-bedded to medium-bedded; some shale partings; can be divided into five members.	Only about 200 square miles in extent in area of study. Where saturated, fractures and solution cavities in rock generally yield small supplies to wells. Records of 23 wells show an average yield of 23 gpm. Water is generally under artisan pressure where overlain by Decorah Shale. Not considered to be an important source of water in area of study.
	Glenwood Shale	0-18	Shale, bluish-gray to bluish-green; generally soft but becomes dolomitic and harder to the east.	Confining beds; locally, some springs issue from the Glenwood-Platteville contact in the river bluffs.

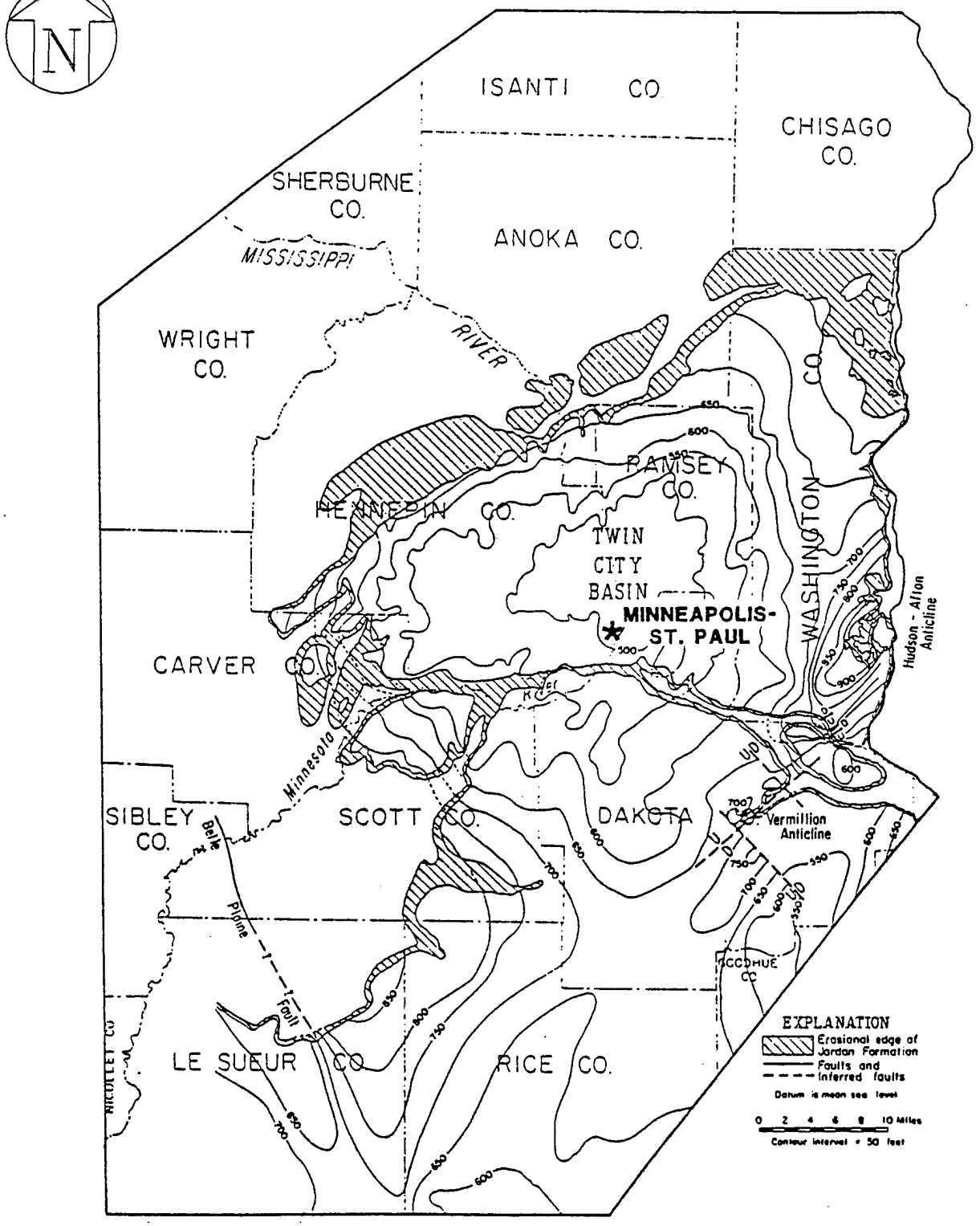
Table 3.1 (Continued)
Regional Geologic Units and Their Water-Bearing Characteristics
Twin Cities Basin, Minnesota

System	Geologic Unit	Approximate Range in Thickness (in feet)	Description	Water-Bearing Characteristics
Ordovician (Concluded)	St. Peter Sandstone	0-150+	Sandstone, white, fine- to medium-grained, well-sorted, quartzose; locally iron-stained and well cemented; rounding and frosting of grains is common, 5-50 feet of siltstone and shale near bottom of formation.	About 650 square miles in extent in Minnesota part of study area; not fully saturated throughout area. Most wells completed in the sandstone are of small diameter and used for domestic supply. They yield 9 to 100 gpm with 1 to 21 feet of drawdown. Two wells known to be used for public supply have been pumped at 600 and 1,250 gpm. Water occurs under both confined and unconfined conditions. Confining bed near bottom of formation seems extensive and hydraulically separate sandstone from underlying Prairie du Chien-Jordan aquifer. Not considered to be an important source for public supplies in area of study, but is suitable source for domestic supplies.
Prairie du Chien Group	Shakopee Dolomite		Dolomite, light brown to buff, thinly to thickly bedded, cherty; shale partings; commonly sandy and oolitic.	About 2,000 square miles in extent in Minnesota part of study area. Together, the Prairie du Chien dolomite and Jordan Sandstone constitute the major aquifer unit in the area. The two are hydraulically connected throughout most of the area, but locally some small head difference may exist owing to intervening low-permeable confining beds of limited extent.
	New Richmond Sandstone	0-250+	Sandstone and sandy dolomite, buff, often missing.	
	Oneota Dolomite		Dolomite, light brownish-gray to buff, thinly to thickly bedded, vuggy.	Prairie du Chien: Permeability is due to fractures, joints and solution cavities in the rock. Yields small to large supplies of water to wells. Pumping rates of up to 1,800 gpm have been obtained.

Table 3.1 (Concluded)
Regional Geologic Units and Their Water-Bearing Characteristics
Twin Cities Basin, Minnesota

System	Geologic Unit	Approximate Range in Thickness (in feet)	Description	Water-Bearing Characteristics
Cambrian	Jordan Sandstone	0-100+	Sandstone, white to yellowish fine- to coarse-grained, massive to bedded, cross-bedded in places; quartzose, commonly stained; loosely to well cemented.	Prairie du Chien-Jordan aquifer: Supplies about 75 percent of groundwater pumped in the metropolitan area. Yields of 115 wells (3- to 24-inch diameter casings), open to both rocks, ranged from 85 to 2,765 gpm with 3 to 133 feet of drawdown. Higher obtainable yields seem to reflect closeness to the Mississippi and Minnesota Rivers or to places where the aquifer is overlain directly by glacial deposits particularly where drift-filled valleys penetrate. Jordan: Permeability is most intergranular but may be due to joint partings in cemented parts. Main source of water for public supply in metropolitan area. Almost all wells completed in the sandstone area of large diameter. Recorded yields are from 36 to over 2,400 gpm with 2 to 155 feet of drawdown.

Source: CH2M Hill, 1983.



SOURCE: MODIFIED FROM J.H. MOSSLER, 1972, PAGE 469.

FIGURE 3.2

MINN/BIOSTRUC

GEOLOGIC STRUCTURAL MAP OF THE TWIN CITIES BASIN
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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buried paleovalley exists immediately west of the airport, with several smaller valleys to the north and south.

3.1.2.2 Local Geology

The Minneapolis-St. Paul IAP is underlain by Paleozoic bedrock units found in the Twin Cities Basin (see Figure 3.1) and a variety of glacial sediments. The units encountered in borings at the airport, from youngest to oldest, are:

- ORDOVICIAN DECORAH SHALE – occurs as an erosional remnant in the northern portion of the airport. Where the Decorah Shale is present, its thickness ranges from 1.7 to 5.5 feet. The formation consists of fissile to blocky, greenish-gray to olive gray calcareous highly fossiliferous shale. It generally does not yield water.

- ORDOVICIAN PLATTEVILLE FORMATION – underlies the Decorah Shale, where present, and unconsolidated glacial deposits where the Decorah is absent. The Platteville Formation is composed of thin to medium-bedded, gray and yellowish-brown dolomite and dolomitic limestone. The Platteville Formation has a maximum thickness of 30 feet at the IAP complex. The Platteville Formation is water-bearing.

- ORDOVICIAN GLENWOOD SHALE – is very thin, grayish-green calcareous shale, ranging in thickness from three to ten feet. The Glenwood Shale serves as a lower confining bed to the overlying Platteville Formation.

- ORDOVICIAN ST. PETER SANDSTONE – underlies the Glenwood Shale. The St. Peter Sandstone is fine- to medium-grained, well-sorted and friable, light grey to yellowish-white sandstone. The thickness of the St. Peter Sandstone ranges from 151 to 162 feet.

- ORDOVICIAN PRAIRIE DU CHIEN GROUP – comprises two principal formations, the Shakopee Formation and the Oneota Dolomite. Both units are predominantly buff dolomite which is vuggy and fractured. This Group varies in thickness from 121 to 146 feet.

- CAMBRIAN JORDAN SANDSTONE – is composed of yellow, fine- to coarse-grained quartzose sandstone ranging in thickness from 72 to 85 feet. The Jordan Sandstone and overlying Prairie du Chien function as one aquifer.

A sequence of unconsolidated glacially derived sediments, ranging in thickness from a few feet to over 225 feet, covers the eroded Paleozoic bedrock surface. The thicker sections of unconsolidated sediments fill paleovalleys. (Braun, 1993)

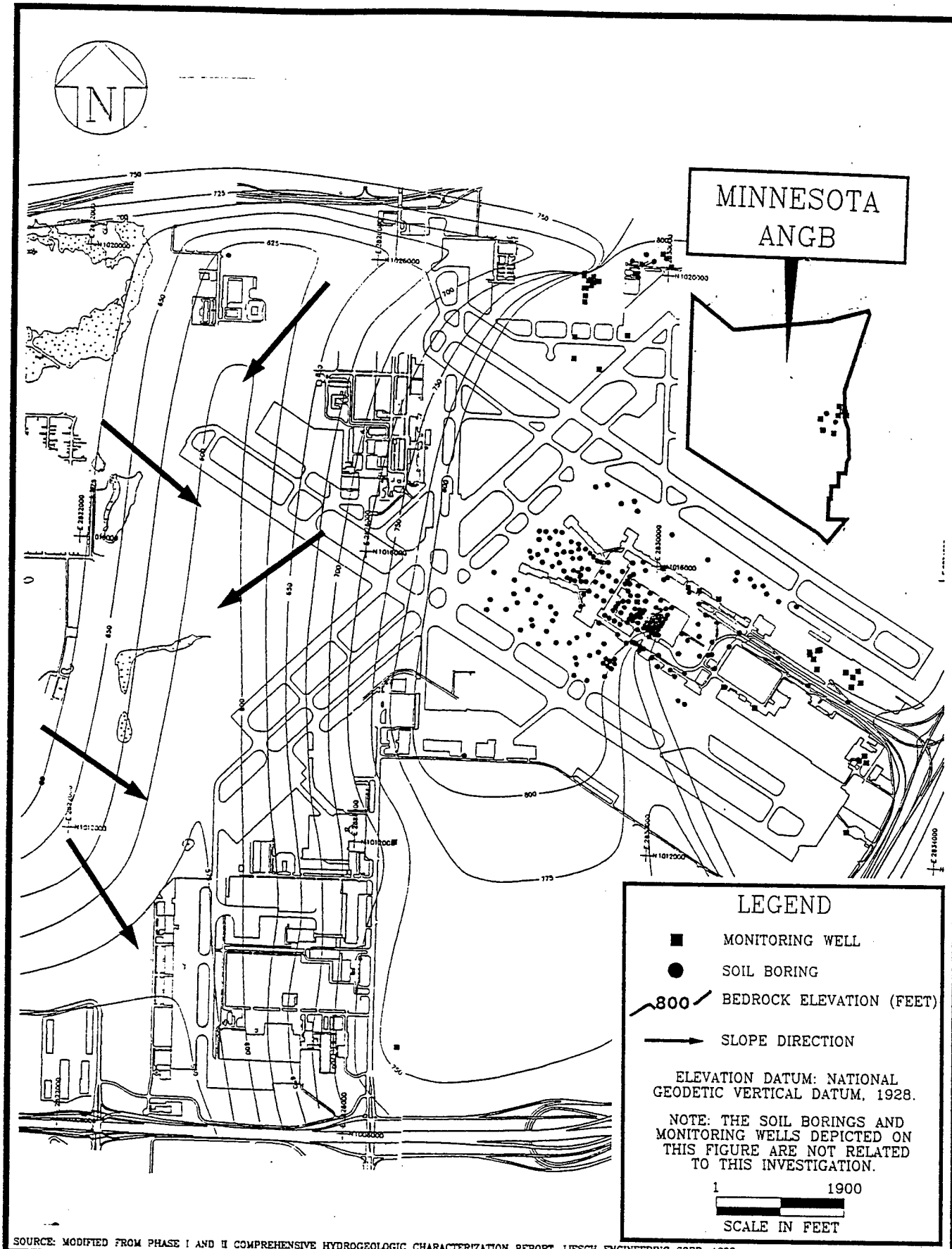
The bedrock topography of the IAP complex is illustrated in Figure 3.3. Underlying much of the IAP complex is a large relatively flat plateau capped by the Platteville Limestone. The plateau is bordered to the south and east by the Minnesota River valley and on the west by a large buried paleovalley. (Liesch, 1992)

3.1.2.3 Surficial Geology

The upper 30 feet or less of unconsolidated sediments at the IAP complex consist of sand and clay. The sand unit consists predominantly of fine- to coarse-grained sand and gravel with isolated lenses of clay, generally less than one foot thick. The clay unit consists of interbedded clay and sand. The clay horizons vary in thickness from one to 14 feet and tend to be laterally discontinuous. The sand horizons are fine- to coarse-grained. These sediments are comprised primarily of clay-rich glacial till and lesser amounts of sandy outwash deposits. The surficial geology was described by Liesch (1992) as "glacial till, outwash, lake deposits, and alluvium of several ages; vertical and horizontal distribution of units is complex."

3.1.3 Soils

The base falls within an area that is highly urbanized, and therefore, was excluded from the Hennepin County Soil Survey (U. S. Department of Agriculture, 1994). The urban development, along with reworking of the soils during construction, made it impractical to accurately classify the native soils. The Minnesota Soil and Water Conservation District classifies the soil type at the Base to be "Urban Land, industrial, sandy substratum." The terrain for this type of soil is generally level to rolling, with soils being sand or gravel having fair to good drainage (Minnesota Soil & Water Conservation District, 1995).



SOURCE: MODIFIED FROM PHASE I AND II COMPREHENSIVE HYDROGEOLOGIC CHARACTERIZATION REPORT, LIESCH ENGINEERING CORP. 1992.

FIGURE 3.3

MINNEAPO\BEDROCK

BEDROCK TOPOGRAPHY AT
MINNEAPOLIS-ST. PAUL IAP
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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3.1.4 Hydrogeology and Groundwater Use

Hydrogeologic units of regional significance beneath the study area include the St. Peter Aquifer and the Prairie du Chien-Jordan Aquifer. Deeper aquifers of regional significance include the Franconia-Irontown-Galesville Aquifer and the Mt. Simon-Hinckley-Fond du Luc Aquifer. Of these, the St. Peter is the uppermost major aquifer underlying the IAP complex. Sections of the St. Peter Aquifer in the base vicinity are under unconfined conditions. The top of the St. Peter Aquifer is approximately 50 feet BLS at the base (Liesch, 1992). Perched zones in the surficial aquifer exist above these major aquifers. Perched groundwater zones and the surficial aquifer lie within the glacial outwash deposits above the New Ulm Till deposits and in the Platteville Formation above the Glenwood Shale. The St. Peter Aquifer is confined by the Glenwood Shale. Recharge to this aquifer is by infiltration in outcrop areas, where the confining Glenwood Shale above the aquifer is absent, and through the till-filled paleovalley which trends in a north to south direction just west of the main IAP runway complex (Figure 3.2). Discharge is eastward and southeastward to the Minnesota River. Several small-yield domestic wells exist in this aquifer west and south of this area; however, the St. Peter Aquifer is generally not utilized as a water supply in the vicinity of the study area. Where utilized, the typical yield for individual wells ranges from 9 to 100 gallons per minute (gpm). Approximately 15 percent of the groundwater utilized in the Twin Cities metropolitan area comes from this aquifer. In general, the groundwater quality of the aquifer is high with less than 500 ppm total dissolved solids.

The Prairie du Chien-Jordan Aquifer lies beneath the St. Peter Aquifer. Basal silts and shales of the St. Peter Sandstone act as confining substratum to this aquifer. Regionally, the Prairie du Chien-Jordan Aquifer is a major water supply source. The aquifer consists of two geologic units, the Prairie du Chien (dolomitic limestone with minor sandstone) and the Jordan Sandstone, which respond dominantly as a single hydrogeologic unit which dips to the north at approximately 10 feet per mile. The top of the aquifer occurs at a depth of approximately 210 to 230 feet BLS in the vicinity of the study area. The water level within the aquifer is approximately 134 feet BLS and is under 76 to 96 feet of artisan head. Groundwater flow in the aquifer is to the east. Recharge to the aquifer occurs by infiltration from river channels which have cut through the basal confining layer of the St. Peter Sandstone and by infiltration along solution channels and sinkholes within the carbonate units of the Prairie du Chien Group. The Prairie du Chien Aquifer supplies 75 percent of the groundwater supplies pumped in the metropolitan area. Well yields of the aquifer vary from 85 to 2,765 gpm with drawdowns of 3 to 133 feet. The water quality of the aquifer is good with less than 500 ppm total dissolved solids.

The general groundwater flow direction for near-surface perched water is to the northwest to north (Liesch, 1992). This would include groundwater within the upper Platteville Limestone and the overlying Decorah shale and over burden.

Water wells in a one-mile radius of Minnesota ANGB and their associated unique well numbers, ground surface elevations, elevations of casing, static water levels, aquifers, and uses are listed in Table 3.2 and are presented in Figure 3.4. These wells are used for commercial and domestic purposes. Of seven total wells, two are for commercial usage, two are for domestic usage, and the usage on three wells was not listed on the well logs.

3.1.5 Surface Water

The IAP complex is located near the confluence of the Minnesota and Mississippi Rivers. More than 100 lakes are located within the Hennepin county borders. Of them, Lake Minnetonka is the largest (nearly 15,000 acres), located approximately 15 miles west of the IAP complex. Other important lakes include the Independence, the Medicine, and the Sarah. All the streams and rivers in the county eventually drain into either the Mississippi River or the Minnesota River, which are located along the southern and eastern boundaries, respectively, of the IAP complex.

Surface water runoff from the base is generally to the south and east towards the Minnesota River. Surface water runoff is collected by a system of storm sewers which ultimately discharge into the Minnesota River.

The Twin Cities metropolitan area utilizes approximately 140 million gallons per day (mgd) of surface water. Groundwater supplies account for an additional 200 mgd in the metropolitan area. The base water supply is obtained from the City of Minneapolis water distribution system.

3.1.6 Critical Habitats/Endangered or Threatened Species

The State of Minnesota Department of Natural Resources classifies various lakes and wetlands as Protected Waters or Wetlands and strictly controls any projected modifications of water courses, currents, or cross-sections of these protected areas.

Plant communities at the developed military sites, residential areas, and parks consist of either ornamental, early successional, or remnants of historic natural forest and prairie land (Base

Table 3.2
Water Wells in 1-Mile Radius
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

Unique Well Number	Ground Surface Elevation	Screen Interval	Elevation of Casing	Static Water Level	Aquifer	Use
151585	NA	NA	None	90'5" BLS	NA	Commercial
161497	836' ± 5'	OH	None	122' BLS	Jordan Sandstone	Commercial
208322	NA	NA	None	77' BLS	Jordan Sandstone	NA
208321	NA	OH	None	92' BLS	Jordan Sandstone	NA
208323	814'	OH	None	85' BLS	Jordan Sandstone	Domestic
208324	815' ± 3'	OH	None	83' BLS	Jordan Sandstone	Domestic
208320	NA	NA	NA	93' BLS	Jordan Sandstone	NA

NA – Not Available.
' – feet.
UNK – Unknown.
Source: Minnesota Geological Survey.

BLS – Below Land Surface.
" – inches.
OH – Open hole.

SOURCE: OPTECH, 1995-MINNESOTA GEOLOGICAL SURVEY

FIGURE 3.4

MINN\MILE-RAD

WATER WELL LOCATIONS WITHIN ONE-MILE RADIUS OF ANGB MINNEAPOLIS

133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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Comprehensive Plan, Natural Resources, Draft, 1990). Animals include squirrels, birds, and other species comfortable in the urban environment.

The Minnesota and Mississippi Rivers to the east and south of the IAP complex area are protected on both banks by City and State Parks, and the Minnesota River National Wildlife Refuge. The Minnesota Natural Heritage database maintained by the Minnesota Department of Natural Resources lists Federal and state rare plants and animals reported across the state. Listings within a one-mile radius of the IAP complex area are from sightings and study of the flora and fauna at Fort Snelling State Park and the National Wildlife Refuge. The following significant natural features and rare flora and fauna are known to occur within two miles of the confluence of the two rivers:

Rare Flora and Fauna	State Status
Calcareous Fern (natural feature)	Endangered
Carex sterilis (sterile sedge)	Threatened
Cypripedium candidum (small white lady slipper)	Special concern
Oxypolis rigidor (cowbane)	No legal status
Rhynchospora capillacea	Threatened
Valeriana edulis ssp. *ciliata*	Threatened
Emydoidea blandingii (Blanding's turtle)	Threatened
Lampropeltis triangulum (Eastern milk snake)	Special concern
Elaphe vulpina (Fox snake)	Special concern
Vireo bullii (Bell's vireo)	Rare, no legal status
Haliaeetus leucocephalus (Bald Eagle)	Endangered

Endangered species have not been documented at or in the immediate vicinity of the IAP complex site. Furthermore, the IAP complex site does not provide suitable habitats for endangered species known to exist within two miles of the base area. Therefore, these sites are not considered to be ecologically sensitive.

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SECTION 4.0 FIELD PROGRAM

The purpose of the SI was to investigate the potential for petroleum hydrocarbon contamination at UST – Sites No. 1, No. 2, No. 3, and No. 4 at the Minnesota ANGB, and to provide data needed to determine if additional investigative or remedial actions are warranted. This section describes the field activities performed during the SI to accomplish these objectives, and the methodologies used to conduct the activities. The initial SI field work commenced on 31 July 1995 and was completed on 17 August 1995. OpTech returned the week of 17 September 1995 to conduct a second round of groundwater sampling and to install and sample an additional monitoring well at UST – Site No. 4 (651-001MWB). A second groundwater sample was collected from 651-001MWB on 26 October 1995.

4.1 GENERAL INVESTIGATION APPROACH

Petroleum hydrocarbon contamination detected at all the sites is apparently related to UST leakage and/or operations. The initial investigations performed by Bay West identified residual soil contamination at levels of concern within the UST excavation. The techniques used during this SI were selected to evaluate the degree of potential contamination of the native soil adjacent to the UST excavation and to evaluate potential impacts to groundwater.

The investigative techniques included the drilling and sampling of soil borings adjacent to the UST excavations; installation and sampling of monitoring wells in the inferred downgradient direction of groundwater flow; laboratory analysis of soil and groundwater samples; and evaluation of subsurface geology, groundwater flow conditions, and hydraulic conductivity.

4.2 DEVIATIONS FROM THE WORK PLAN

The following deviations from the Site Investigation Work Plan occurred:

- Soil boring 651-005BH and the initial location for monitoring well 651-001MW at UST – Site No. 4 were abandoned prior to attaining total depth when pieces of an apparent plastic liner, such as that described as installed within the UST excavation, were noted within soil samples. No soil or groundwater samples were analyzed from these locations. Soil boring 651-007BH was drilled to replace abandoned soil boring 651-005BH. Monitoring well 651-001MW was relocated and designated as 651-001MWA. The ANGRC/CEVR project manager was notified of the relocations.

- Soil boring 801-002ABH at UST – Site No. 3 was abandoned prior to attaining total depth when pieces of an apparent plastic liner, such as that described as installed within the UST excavation, were noted within a soil sample. No soil or groundwater samples were analyzed from this location. Soil boring 651-002BH was drilled in an alternate location as a replacement. The ANGRC/CEVR project manager was notified of the relocation.

- An additional monitoring well (651-001MWB) was installed at UST – Site No. 4 to provide information on groundwater conditions within the bedrock aquifer. The ANGRC/CEVR project manager approved the monitoring well and modified the contract accordingly.

- Mud rotary techniques were substituted for hollow-stem auger (HSA) methods for drilling the overburden section of bedrock monitoring well 651-001MWB. Soil samples were not collected from this monitoring well borehole since the location was within ten feet of monitoring well 651-001MWA which had previously been sampled. The ANGRC/CEVR project manager approved the alternative drilling technique.

- Rock cuttings generated by air rotary drilling through the bedrock section of the monitoring well were not screened for BTEX with the field gas chromatograph (GC).

4.3 FIELD SCREENING ACTIVITIES

Soil and groundwater sample screening was performed during the field investigation to provide immediate information on contaminant concentrations at the boreholes, and to aid in the selection of soil samples to be submitted for laboratory analysis.

During sampling of soil borings, the air around the soil sampler was monitored with a Thermo Environmental Model 580B PID immediately upon opening the sampler (to maximize the detection of volatiles). All soil samples collected were placed in clean glass containers with aluminum foil caps for approximately 15 minutes and allowed to reach approximate ambient air temperature. A PID used to conduct ambient temperature headspace analyses (ATHA) for volatile compounds. PID readings are listed on the boring logs included in Appendix A. Soil samples were also screened using a Photovac Model 10S+ Portable GC. The field GC, calibrated to screen for BTEX, was used to detect the presence of these compounds in the

headspace from the soil samples collected. Headspace analyses with the PID and field GC was used to provide immediate information as to the environment of the borehole and to supplement analytical laboratory data. Field GC data is summarized in Subsections 5.2.1, 5.3.1, 5.4.1, and 5.5.1, Field Screening Results. All field GC screening results are presented in Appendix C.

4.4 CONFIRMATION ACTIVITIES

Maxim Technologies, Inc., of St. Paul, Minnesota, was retained as the drilling contractor for the drilling of soil borings and installation of monitoring wells. The selected drilling contractor mobilized personnel and equipment that satisfied Minnesota ANGB and State of Minnesota requirements.

Southern Petroleum Laboratories, Inc. (SPL), of Houston, Texas, was retained to perform laboratory analyses on soil and groundwater samples. Provisions were made for proper sample containers, labels, chain-of-custody forms, sample stabilization and preservation, and packing materials by the selected laboratory. SPL is an MPCA-certified laboratory.

Comstock & Davis, Inc., of Minneapolis, Minnesota, was retained as the surveying contractor. The buildings, soil boring locations, and monitoring well locations at each UST site were surveyed. Comstock & Davis, Inc., is a state-certified licensed surveyor. The land surface elevation of each soil boring and monitoring well, as well as the elevations of the monitoring well casings is shown on the soil boring logs and monitoring well construction logs (Appendix A and B).

4.4.1 Soil Borings

Soil borings were drilled to obtain soil samples for laboratory analysis for confirming the presence or absence of subsurface soil contamination. Soil samples were also used for determining site geology and subsurface soil characteristics.

A total of 18 soil borings were installed. All work was performed in a manner consistent with MDH laws and regulations. Soil borings were advanced from surface to the depth at which groundwater was encountered, or until auger refusal occurred, whichever occurred first. Total depths of the soil borings ranged from 9.8 to 19.0 feet BLS. All soil boring locations and elevations were determined by the surveyor contracted for Minnesota ANGB field work.

4.4.1.1 Drilling With Hollow-Stem Auger

Soil borings were completed by using HSA methods at the UST sites. The HSA drilling method employs a hollow helical steel drill tool that is rotated to advance the boring and lift formation materials (cuttings) to the surface. The flights (the helical steel blades) for the HSA are welded onto steel pipe and a cutter head is attached to the "lead" (bottom) auger to cut the hole. During drilling, a center bit is inserted into the hollow area of the cutter head that prevents cuttings from re-entering the hollow portion of the auger. Generally, the center bit is flush with or extends no more than 1/2 foot below the cutter head. The center bit connects through the auger flights by small-diameter drill rods and is attached to the top-head drive unit of the drill rig. The top-head drive is powered by a truck-mounted engine that mechanically rotates the entire flight of augers. The hollow opening allows the insertion of sampling tools (i.e., split-spoon sampler) with the augers in place to prevent caving of the borehole.

Soil samples were collected from surface to total depth of the soil borings for subsurface characterization, field screening, and laboratory analyses. Depending on site conditions, 18- to 24-inch carbon steel California-style samplers equipped with three to four 6-inch brass sleeves were used for collecting soil samples for laboratory analysis. Actual sample depths submitted for laboratory analysis are discussed in Subsections 5.2.2, 5.3.2, 5.4.2, and 5.5.2, and shown on the soil boring logs included in Appendix A. The California-style sampler was decontaminated, and unused new brass sleeves inserted, prior to collecting each soil sample.

The drilling rig, auger flights, and tools were thoroughly steam-cleaned in the designated decontamination area near the washrack area before initial use and after the completion of drilling at each former UST.

Borehole abandonment conformed to applicable MDH requirements. All HSA borings were backfilled with cement-bentonite grout after sampling was accomplished to inhibit the downward migration of contaminants through the open borehole.

4.4.2 Monitoring Well Installation

Six monitoring wells were installed to obtain water level data for hydrogeologic characterization of the aquifer, evaluate horizontal groundwater flow characteristics, and obtain groundwater samples for laboratory analysis. One monitoring well was installed at UST – Sites No. 1 through No. 3 in the inferred downgradient direction (northwest) from the UST excavation.

Three monitoring wells were installed at UST – Site No. 4. Monitoring wells were constructed in accordance with MDH well construction specifications.

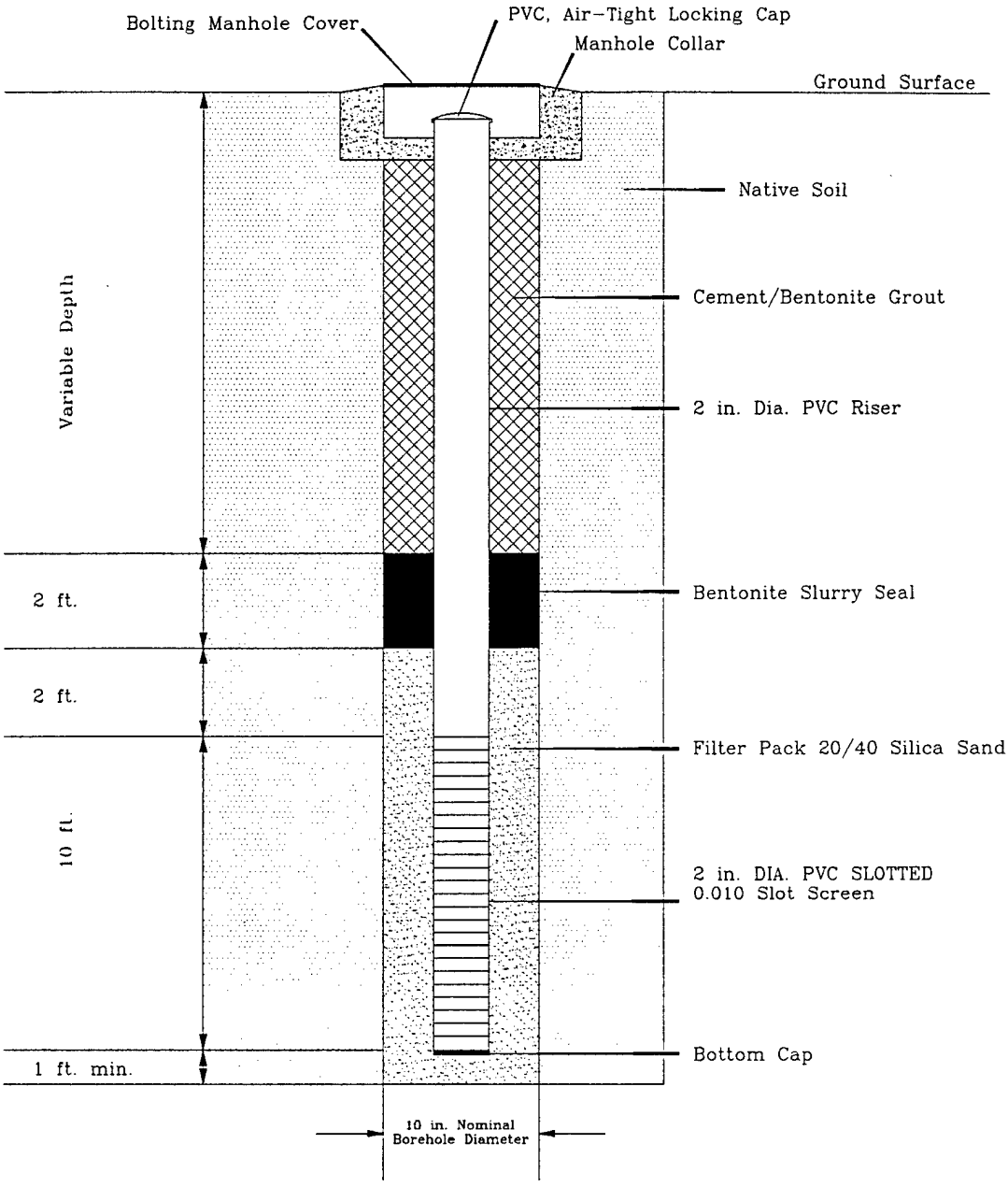
The drilling rig, auger flights, and tools were steam-cleaned in the designated decontamination area near the washrack area before initial use and after the completion of each monitoring well. New casing and screens were used for all monitoring wells and were unpackaged immediately prior to installation to insure freedom from any contamination before placement within the wellbore.

All monitoring wells were completed by flush surface mount. Wells completed by flush surface mount are required to have a 2- to 3-inch grade above the land surface as specified by the MDH (Figure 4.1). The Minnesota ANGB Environmental Manager reviewed and approved the monitoring well surface completion specifications for each site. The casing was cut approximately 2 inches above land surface and installed with a protective locking lid consisting of a cast-iron valve box assembly. The valve box was placed in the center of the hole with the top just above the ground surface. Concrete was placed around the annular space and sloped away from the valve box to divert drainage. The well was also fitted with a locking watertight compression casing cap to prevent infiltration of surface water. The well was equipped with a bolted metal cover. The site well number was clearly marked on the valve box lid and well casing. All well assemblies were secured with either a brass or stainless steel lock. A set of lock keys were given to the Minnesota ANGB Environmental Manager; one set of keys has been retained by OpTech.

4.4.2.1 Monitoring Wells Completed in Unconsolidated Soil

Monitoring wells 651-001MWA, 801-001MW, and 873-001MW were completed in unconsolidated soil to depths of 15.2 feet BLS, 12.0 feet BLS, and 11.1 feet BLS, respectively. Soil was sampled while drilling the monitoring wells at 5-foot intervals from surface to total depth for field screening and geologic classification. Soil samples from the boreholes of the monitoring wells were not submitted for laboratory analysis.

Monitoring wells completed in unconsolidated soils were constructed of 2-inch inner-diameter (ID), flush-threaded, polyvinyl chloride (PVC) casing and screens, and a bottom cap (see Figure 4.1). A sand pack, composed of washed silica sand, was placed around the screen to a point at least 2 feet above the top of the screen. A bentonite slurry seal (surface mixed), having a minimum thickness of 1 foot, was placed above the sand pack. Above the bentonite seals, bentonite/cement grout was placed around the casings.



NOT TO SCALE

FIGURE 4.1

MINNEAPO\TYPMONCN

TYPICAL MONITORING WELL CONSTRUCTION
(UNCONSOLIDATED SOIL)
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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4.4.2.2 Monitoring Wells Completed in Rock

4.4.2.2.1 Open-Hole Completion

Monitoring wells 591-001MW and 651-002MW were set into limestone by open-hole completion methods. Open-hole completion methods are an approved MDH construction method in this case, and are approved as suitable for groundwater sample collection by the MPCA (Zadack, 1995). The open-hole completion entailed HSA drilling until rock was encountered (auger refusal). The HSAs were then advanced to a minimum depth of 6 inches into bedrock. A steam-cleaned 4-inch-diameter low-carbon steel casing was set into the bedrock. The annulus was grouted to within approximately 3 feet of land surface with a bentonite-cement grout mix. The grout was allowed to cure a minimum of 24 hours. After the curing period, the open-hole section of the monitoring well was drilled out with an air rotary rig using a 3-7/8-inch diameter tricone rotary bit. The open-hole interval of the monitoring well extended at least 7 feet into the limestone formation. A diagram of the open-hole monitoring well completion is illustrated in Figure 4.2.

4.4.2.2.2 Double-Cased Monitoring Well

Monitoring well 651-001MWB was set into limestone using the double-cased completion method. This completion method was used to complete a monitoring well through the overburden perched water table into the underlying confined aquifer within the Platteville Limestone. The double-cased completion method is an approved MDH construction method in this case, and is approved as suitable for groundwater sample collection by the MPCA (Zadack, 1995).

The double-cased completion entailed mud rotary drilling until rock was encountered. The bit was then advanced to a minimum depth of six inches into bedrock. A steam-cleaned 6-inch diameter low-carbon steel casing was set into the bedrock. The annulus was grouted to within approximately 3 feet of land surface with a bentonite-cement grout mix. The grout was allowed to cure a minimum of 24 hours. After the curing period, the down-hole section of the monitoring well was drilled out with an air rotary rig using a 3-7/8-inch diameter tricone rotary bit. The down-hole interval of the monitoring well extended at least 7 feet into the limestone formation. A diagram of the double-cased monitoring well completion is illustrated in Figure 4.3.

The monitoring well was completed as described in Subsection 4.4.2.1.

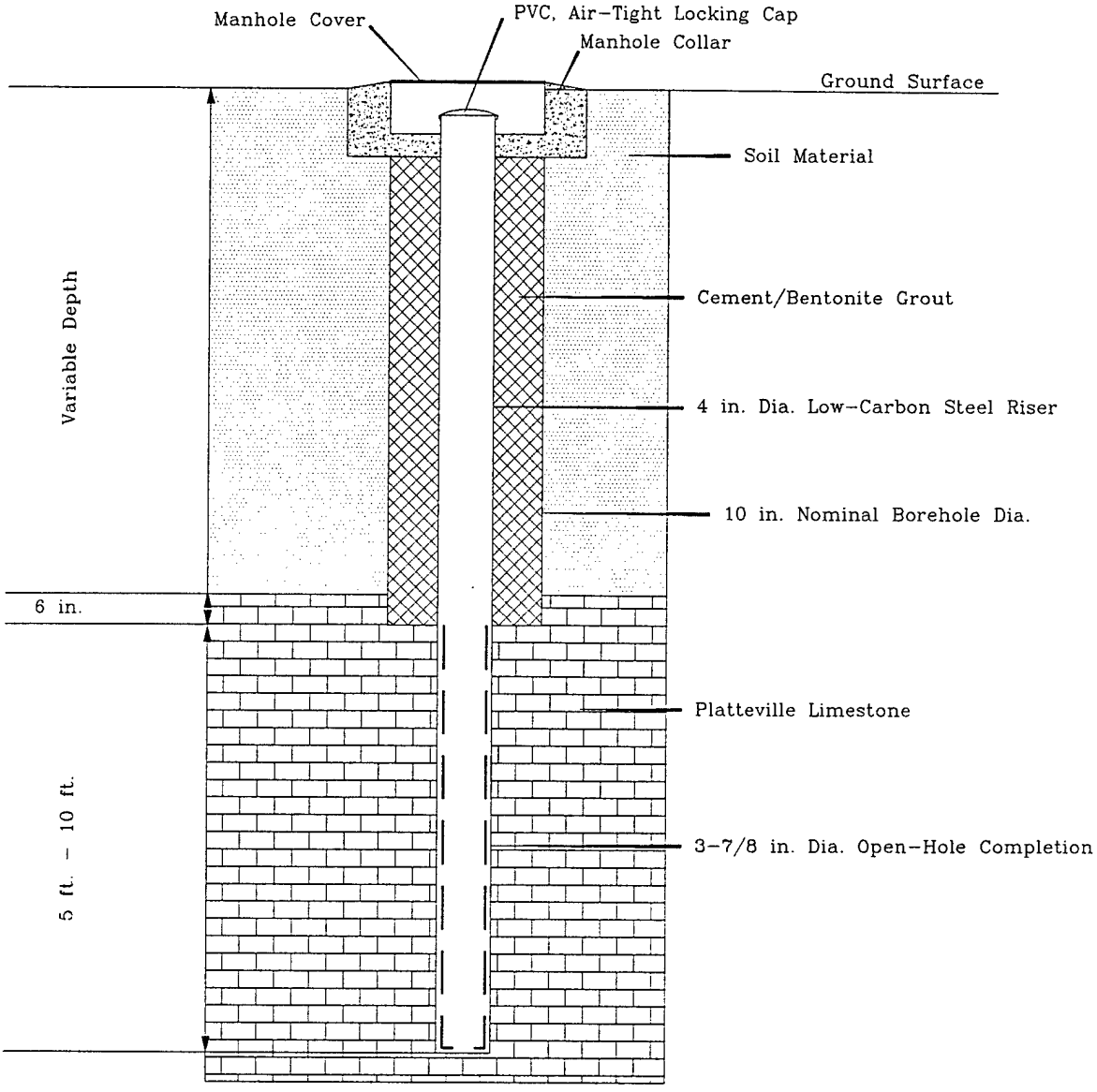

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FIGURE 4.2

MINNEAPO\OHCOMPL

TYPICAL MONITORING WELL CONSTRUCTION
(OPEN-HOLE COMPLETION)
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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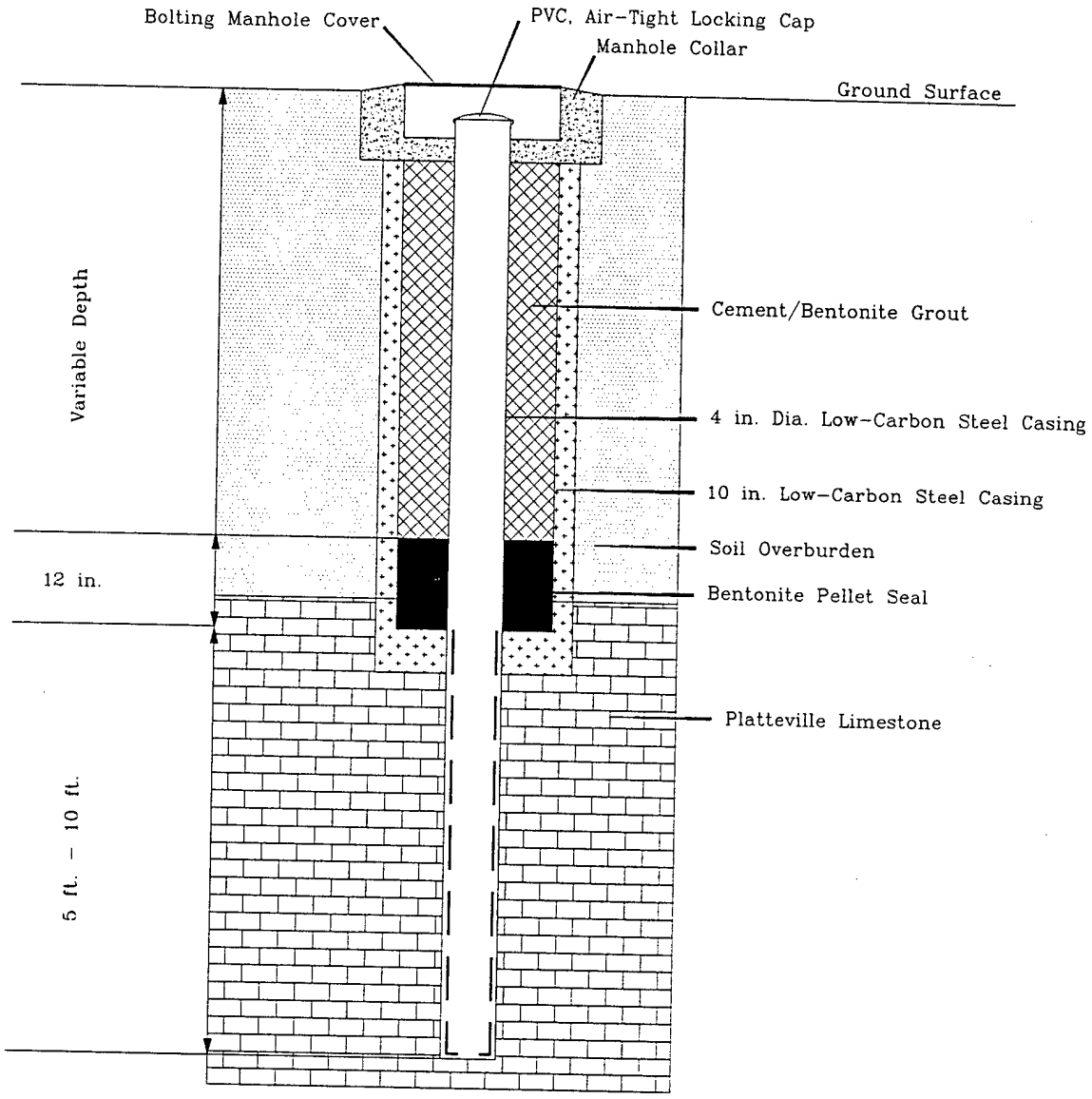

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FIGURE 4.3

MINNEAPO\OHCOMPL2

TYPICAL MONITORING WELL CONSTRUCTION
(DOUBLE-CASED COMPLETION)
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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Surface completions for monitoring wells drilled in rock were the same construction as specified for monitoring wells completed in unconsolidated soil. Development and groundwater sampling procedures for monitoring wells completed in rock were the same as for monitoring wells completed in unconsolidated soil.

The monitoring wells were developed between 24 and 48 hours after well completion to allow sufficient time for the annular grout to set. Well development was conducted using a Teflon™ bailer. A stainless-steel submersible pump at a pumping rate less than 1 liter per minute was used for development of monitoring wells 591-001MW and 651-002MW. Equipment used for well development was decontaminated in accordance with the approved Work Plan.

Well development continued until at least three well volumes had been removed and three successive readings of the temperature, specific conductance, and pH are within the following criteria:

Specific conductance (temperature corrected): + 10 micro Siemens per centimeter (μS/cm);
pH: + 0.1 standard units; and
Temperature: + 0.5° C.

The well volume was calculated as follow: (0.0408) X (Well Diameter in inches)^2 X (Ft. of water column).

4.4.3 Specific Media Sampling

This subsection summarizes the analytical program followed for soil and groundwater samples collected during the SI to determine the nature, magnitude, and extent of contamination detected at the former USTs. Also included in this subsection is a brief discussion of quality control procedures followed during the field sampling activities.

Based on past activities at the UST sites, suspected contaminants included No. 2 fuel oil, waste oil, and AVGAS. To comply with MPCA requirements for petroleum UST spills, the soil and groundwater analytical program focused on the detection of TPH-DRO, total petroleum hydrocarbons as gasoline range organics (TPH-GRO), BTEX, methyl tertiary-butyl ether (MTBE), VOCs, and lead.

Soil samples were analyzed for BTEX using USEPA Method SW-846/8020; USEPA Method SW-846/8240 (UST – Site No. 2 only); MTBE using USEPA Method SW-846/8020 (UST – Site No. 4 only); TPH-DRO/GRO using WDNR modified methods, and lead by USEPA Method SW-846/6010. Groundwater samples were analyzed for VOCs using USEPA Method SW-846/8240; TPH-DRO/GRO using WDNR modified methods, and lead by USEPA Method SW-846/6010. Table 4.1 summarizes the soil and groundwater sample analytical program.

4.4.3.1 Soil Sampling Procedures

4.4.3.1.1 Sampling Unconsolidated Soils

Once the equipment decontamination procedures were completed as specified in Section 4.5, soil sampling was conducted in each soil boring. Soil samples were collected and field screened from surface to total depth at 5-foot intervals. Soil borings were drilled to the water table or auger refusal occurred. Soil sampling of cohesive soils were conducted according to American Society for Testing and Materials (ASTM) D-1587 using a stainless steel California-style sampler, fitted with brass receiving sleeves. A sand catcher was fitted to the sampling assembly to collect non-cohesive soil samples.

The sampling technique utilized both 18- and 24-inch-long California-style soil samplers, depending on site conditions. After the augers were advanced to the sampling depth, the center bit was removed, and the sampler was lowered to the bottom of the hole. A standard penetration test (SPT) was performed according to ASTM D-1587 to evaluate the consistency of undisturbed soil and to advance the split-spoon sampler for sample collection. The split-spoon sampler was first seated 6 inches to penetrate any loose cuttings and then driven an additional 18 inches with blows of a 140-pound hammer falling 30 inches. Blow counts were measured every 6 inches to determine the physical characteristics of the material encountered. Fifty blow counts per 6-inch interval is considered formation refusal. If 50 blows were counted for a 6-inch interval, the split-spoon sampler was removed and the drill stem advanced through the material, unless auger refusal occurred. The number of blows required to drive the split-spoon sampler each of the three 6-inch increments was recorded. The material encountered was classified using the Unified Soil Classification System and described according to ASTM D2488-90, "Standard Practice for Description and Identification of Soils (Visual Manual Procedures)."

When employing an 18-inch (or 24-inch) split-spoon sampler, three (or four) 6-inch brass sleeves were used to collect soil samples. The sleeve selected for laboratory analysis was the one with

Table 4.1
Laboratory Analyses Summary Table
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

UST – Site No.	Matrix	Field Parameters	Lab Parameters & Test Methods	Investigating Samples	Number of Field QA/QC Samples					Matrix Totals
					Trip Blanks	Equipment Blanks	Field Blanks	Field Duplicate	MS/ MSD	
1 (Tank 591)	Soil (Subsurface)	Field Screening using Field GC/PID Soil Classification	BTEX/SW8020 TPH/WDNR DRO	9 9	1	1 1	1 1	1 1	1	11 11
	Groundwater	Field Screening using Field GC, Temperature, pH, Specific Conductance	VOCs/SW8240 TPH/WDNR DRO	2 2	2	1 1	–	–	–	5 3
2 (Tank 873)	Soil (Subsurface)	Field Screening using Field GC/PID Soil Classification	VOC/SW8240 TPH/WDNR DRO Mod	6 6	2	1 1 1	1 1 1	1 1 1	1 1 1	8 8 8
	Groundwater	Field Screening using Field GC, Temperature, pH, Specific Conductance	VOC/SW8240 TPH/WDNR DRO Mod	2 2	–	–	1 1	–	1 1	4 4
3 (Tank 801)	Soil (Subsurface)	Field Screening using Field GC/PID Soil Classification	BTEX/SW8020 TPH/WDNR DRO	6 6	2	1 1	1 1	1 1	1 1	8 8

Table 4.1 (Concluded)
Laboratory Analyses Summary Table
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

UST – Site No.	Matrix	Field Parameters	Lab Parameters & Test Methods	Investigating Samples	Number of Field QA/QC Samples					Matrix Totals
					Trip Blanks	Equipment Blanks	Field Blanks	Field Duplicate	MS/ MSD	
3 (Tank 801)	Groundwater	Field Screening using Field GC, Temperature, pH, Specific Conductance	VOCs/SW8240 TPH/WDNR DRO	2 2	1	–	1 1	–	1 1	5 4
4 (Tanks 651/652)	Soil (Subsurface)	Field Screening using Field GC/PID Soil Classification	BTEX+MTBE/SW8020 TPH/WDNR GRO TPH/WDNR DRO LEAD/SW6010	16 16 16 16	3	2 2 2 2	2 2 2 2	1 1 1 1	1 1 1 1	18 18 18 18
	Groundwater	Field Screening using Field GC, Temperature, pH, Specific Conductance	VOCs/SW8240 TPH/WDNR GRO TPH/WDNR DRO LEAD/SW6010	8 8 8 8	3	1 1	–	2 2	–	11 11 11 11

QA/QC – Quality Control/Quality Assurance.
MS/MSD – Matrix Spike/Matrix Spike Duplicate.
TPH – Total Petroleum Hydrocarbons.
GRO – Gasoline Range Organics.
GC – Gas Chromatograph.
PID – Photoionization Detector.
VOCs – Volatile Organic Compounds.
DRO – Diesel Range Organics.
WDNR – Wisconsin Department of Natural Resources.

the most representative, cohesive, and undisturbed core of soil as determined by observation by the on-site geologist and field screening methods, described in Section 4.3. In most situations, the sleeve at the bottom of the split-spoon sampler best fulfilled these requirements and was selected for laboratory analysis. The sleeve at the top of the split-spoon sampler was usually not selected because it is most likely to contain drill cuttings that were at the bottom of the borehole when the split-spoon sampler was driven. Sufficient volume of soil was recovered at each sampling interval to meet the analytical testing requirements outlined in the Quality Assurance Project Plan (QAPP). In the event that an insufficient volume was obtained, an additional sample was collected immediately beneath the unsuccessful sampling interval.

A minimum of two soil samples were collected from each soil boring. The sample exhibiting the highest PID reading and the sample obtained from the interval immediately above the water table or auger refusal, whichever occurred first, was collected and submitted for laboratory analysis. In the case where the sample collected immediately above the water table or auger refusal exhibited the highest PID reading, the soil sample from the 5-foot BLS interval was selected as the second sample for analysis. During split-spoon sampling, the air around the spoon was monitored with a PID immediately upon opening the sampler (to maximize the detection of volatiles).

4.4.3.1.2 Sampling Rock

Samples of drill cuttings produced while drilling monitoring wells by air rotary techniques into competent rock were collected for visual examination and field screening. An initial cuttings sample was collected that represented the surface of the rock formation and then at approximately 2-foot intervals thereafter to total depth. The cuttings were collected from the exhaust filter bag of the casing and examined for lithology, physical characteristics, and visual indications of contaminant impact. All cutting samples were field-screened as described in Section 4.3. Samples of rock drill cuttings were not submitted for laboratory analyses.

4.4.3.2 Groundwater Sampling Procedures

A groundwater sample was collected from each monitoring well after purging was completed. The groundwater level in the monitoring well was allowed to return to approximately static conditions.

In order to define the variability in the analytical results that may be caused by sampling and sample analysis techniques, two rounds of groundwater sampling were done. Each sampling

round consisted of purging, sampling, and analysis of groundwater from the wells installed during this investigation. The first round of groundwater sampling was completed as soon as possible after well installation was completed, but each well was allowed to stabilize a minimum of 24 hours after development and prior to sampling. The second round of groundwater sampling was performed four weeks after the first round was completed. Immediately prior to collecting a sample, the static water level below the top of the casing in the well was measured and recorded in the field notebook. Whenever feasible, wells expected to be uncontaminated were sampled first, followed by wells with increasing levels of expected contamination. The monitoring wells were purged immediately before sampling. Well purging was conducted using a Teflon™ bailer. A stainless-steel submersible pump at a pumping rate less than one liter per minute was used for purging of monitoring wells, 591-001MW, 651-00MW2, and MW-4. Equipment used for well purging was decontaminated in accordance with the approved Work Plan.

Well purging continued until at least three well volumes had been removed and three successive readings of the temperature, specific conductance, and pH were within the following criteria:

Specific conductance (temperature corrected): + 10 μS/cm;
pH: + 0.1 standard units; and
Temperature: + 0.5° C.

The well volume was calculated as follow: (0.0408) X (Well Diameter in inches)^2 X (Ft. of water column).

Groundwater samples were collected using Teflon™ bailers and monofilament line (a new line was used for each well). Each bailer was decontaminated between wells, as referenced in Section 4.5. The first bailer of water from the well was discarded to insure no trace levels of decontamination fluids were present. All sampling equipment was kept off soil to prevent cross-contamination of the samples (e.g., equipment was placed on polyethylene plastic sheeting).

Groundwater samples collected during the first round of sampling (August 1995) were screened using a field GC, calibrated to screen for BTEX. Field screening was conducted to provide the Project Manager with preliminary water quality information and to supplement data obtained from water samples sent to the laboratory for analytical analysis.

4.4.3.3 Soil Sample Preservation

All soil samples submitted for laboratory analysis collected with a California-style split-spoon sampler were collected in brass sleeves. Immediately upon removal from the split-spoon sampler, the sleeve ends were covered with a Teflon™ barrier, aluminum foil, and fitted with a decontaminated plastic cap. The sleeves were properly labeled, placed in double plastic bags, stored in iced coolers, and chilled to 4° C or less.

4.4.3.4 Groundwater Sample Preservation

VOC and TPH-GRO samples were preserved with no more than 2 drops of a 1:1 solution of hydrochloric acid per 40-milliliter glass volatile organic analysis (VOA) vial having a Teflon™-lined lid. TPH-DRO samples were stored in one-liter amber glass bottles, having Teflon™-lined lids, and preserved with hydrochloric acid. Lead samples were stored in one-liter plastic bottles, having Teflon™-lined lids, and preserved with nitric acid. During storage and transport, groundwater samples were stored in an iced cooler and chilled to 4° C or less.

4.4.3.5 Quality Control of Field Sampling

Field duplicate samples, field blanks, and trip blanks were submitted to the analytical laboratory for assessment of the quality of data resulting from the field sampling program. Field and trip blank samples were analyzed to check for procedural contamination and ambient conditions the site that may have caused sample contamination. Duplicate samples were submitted to provide a quality assurance check on analytical procedures and results.

Five field blank samples, five equipment blank samples, four matrix spike/matrix spike duplicate (MS/MSD) samples, and four field duplicate samples were collected during the subsurface soil investigation. Two field blank samples, two equipment blank samples, two MS/MSD samples, and two field duplicate samples were collected during the groundwater investigation. The level of the quality control effort for the investigation included one field duplicate, one equipment blank, and one field blank for every ten or fewer investigative samples per sample matrix. One laboratory-prepared VOC analysis trip blank, consisting of distilled, de-ionized, ultra pure water, was included along with each shipment of samples. One MS/MSD was collected for every 20 or fewer investigative samples per sample matrix. Matrix samples provide information about the effect of the sample matrix on the analytical methodology.

The quality control level of effort for the field measurement of pH consisted of a pre-measurement calibration using two standard reference solutions each time. This procedure was performed at least once per day or more often as necessary. Quality control effort for field conductivity measurements included a daily calibration of the instrument using standard solutions of known conductivity. Temperature calibration was accomplished with an internal factory-calibrated thermistor.

4.5 DECONTAMINATION PROCEDURES

In order to prevent cross-contamination, all nondedicated sampling equipment (i.e., split-spoon samplers, augers, etc.) were decontaminated prior to use and between samples using the following procedures. Sampling equipment was washed using a brush and laboratory-grade detergent (Alconox™), followed by a rinse with potable water, an ASTM Type II reagent water, and pesticide-grade methanol. Decontaminated sampling equipment was allowed to air dry and wrapped in aluminum foil with the shiny side outward. Wrapped equipment was stored in such a manner as to reduce the potential for accidental contamination.

Testing and monitoring equipment (probes, thermometers, etc.) that came in contact with soil or water samples was decontaminated by rinsing with an ASTM Type II reagent water, and pesticide-grade methanol. The equipment was then allowed to dry completely before being used again. This decontamination procedure was followed immediately after each use of the equipment. Monofilament line was used to lower groundwater sampling equipment into the monitoring wells.

Drilling and testing equipment (drill rig equipment, augers, and split-spoon samplers) were decontaminated prior to use and between borehole/monitoring well installation. Equipment was moved to a specific decontamination area where the equipment was thoroughly steam-cleaned.

4.6 DETERMINING AQUIFER PROPERTIES

The hydraulic conductivity of the sediments was determined using rising head slug tests conducted at all monitoring wells installed as part of this SI. In the rising head slug method, a decontaminated 1.5-inch-diameter, 3-foot-long slug, constructed of solid acrylic, was lowered into the water column as quickly as possible without causing the water in the well to be greatly disturbed or introducing outside water into the well. The slug was lowered below the water surface until maximum displacement of water had occurred. After the water level rises in response to the slug, the water level in the well was monitored by the data logger as it returned

to the initial static level. The pressure transducer was suspended approximately 3 inches below the bottom of the well casing and secured in a manner to prevent movement during the slug test. The transducer was attached to a Hermit data logger, and calibration standards were entered according to the manufacturer's specifications. The slug was removed from the well after the pre-displacement water level was reached. The water level initially dropped as the slug was being removed from the water, and then rose toward the initial static level in the well. The rise in water level was then measured at closely spaced time intervals. The resulting data, obtained while the water level was rising to its static level, were used to compute hydraulic conductivity.

Porosity of the hydrologic unit was estimated based on lithology classification and published average values for geologic media. Groundwater level measurements collected from the monitoring wells were used to estimate the general direction and magnitude of groundwater flow and gradient.

The average linear velocity of groundwater at the sites was calculated with the following formula:

$$V_x = KI/ne$$

Where:

V_x = Average linear groundwater velocity (feet per day)
K = Hydraulic conductivity (feet per day)
I = Hydraulic gradient (feet per day)
ne = Net effective formation porosity (percent)

4.7 INVESTIGATION DERIVED WASTE

During the SI, a certain amount of investigation derived waste (IDW) material (drill cuttings, decontamination water, and development/purge water) was produced as a result of investigation activities. The Tanks and Spills Division of the MPCA allows the return of petroleum-impacted soil cuttings and groundwater to the site if no free product is present in the waste (Zadack, 1995). No analytical testing is required for disposal.

4.7.1 Disposition of Purged Groundwater and Spent Decontamination Water

With the exception of groundwater purged from monitoring well 651-001MWB, which exhibited a strong hydrocarbon sheen and minute droplets of free product, all purged groundwater and spent decontamination water was vented to the ground surface at each site. Purged groundwater from monitoring well 651-001MWB was stored in a plastic-lined, steel 55-gallon drum. The drum was sealed, marked with contents, accumulation date, contractor's name and phone number, and monitoring well identification number. At this time, the drum is stored in an enclosed space to prevent freezing.

4.7.2 Disposition of Soil Cuttings

No free product was observed in soil cuttings generated during drilling and soil sampling. At the request of the Minnesota ANGB Environmental Manager, all soil cuttings were disposed of in a central location, known as the Pole Yard. At this location, all the soil excavated during the UST removal is stored in piles segregated by UST site. The cuttings from the soil borings and monitoring wells at each UST site was deposited in the appropriate pile for each UST site.

4.7.3 Disposition of Miscellaneous IDW

There was no miscellaneous IDW produced during the SI. Personal protective equipment (PPE) was decontaminated and maintained. Nitrile gloves, Visqueen™ sheeting, and other disposable items that came in contact with soils or groundwater were decontaminated and discarded in a general refuse container.

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SECTION 5.0 INVESTIGATION FINDINGS

This section presents the investigative results for UST – Site No. 1, UST – Site No. 2, UST – Site No. 3, and UST – Site No. 4. Laboratory analyses performed on soil and groundwater samples collected from all sites, two rounds of water level data collected from all monitoring wells, slug test analysis performed on all monitoring wells, and geologic interpretation based on field observation are presented in this section. Table 5.1 summarizes the depths of the soil borings at each site. Monitoring well depth, screened interval, and water levels for each site are summarized in Table 5.2. A project area water level map for 16-17 August 1995, a project area geologic cross-section, and a project area potentiometric map for 22 September 1995 are presented in Figures 5.1, 5.2, and 5.3, respectively.

Table 5.1
Soil Boring Depth Summary
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

UST – Site No.	Borehole Identification Number	Work Plan Proposed Drill Depth (ft. BLS)	Actual Drill Depth (ft. BLS)
1	591-001BH	10.0	17.5
	591-002BH	10.0	14.0
	591-003BH	10.0	15.0
	591-004BH	10.0	19.0
2	873-001BH	13.0	10.7
	873-002BH	13.0	11.7
	873-003BH	13.0	11.3
3	801-001BH	13.0	15.5
	801-002BH	13.0	10.7
	801-003BH	13.0	11.3
4	651-001BH	16.0	11.6
	651-002BH	16.0	10.0
	651-003BH	16.0	9.8
	652-004BH	16.0	10.0
	652-005BH	16.0	15.0
	652-006BH	16.0	16.5
	652-007BH	16.0	15.3

ft. BLS – feet Below Land Surface. BH – Borehole.
UST – Underground Storage Tank.

5.1 UST – SITE NO. 1 (FORMER UST 591) – MPCA LEAK NO. 6686 INVESTIGATIVE FINDINGS

Four soil borings were drilled at UST – Site No. 1 for collection of 10 soil samples for laboratory analyses. Soil samples were analyzed for BTEX by USEPA Method SW-846/8020

Table 5.2
Monitoring Well Summary
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

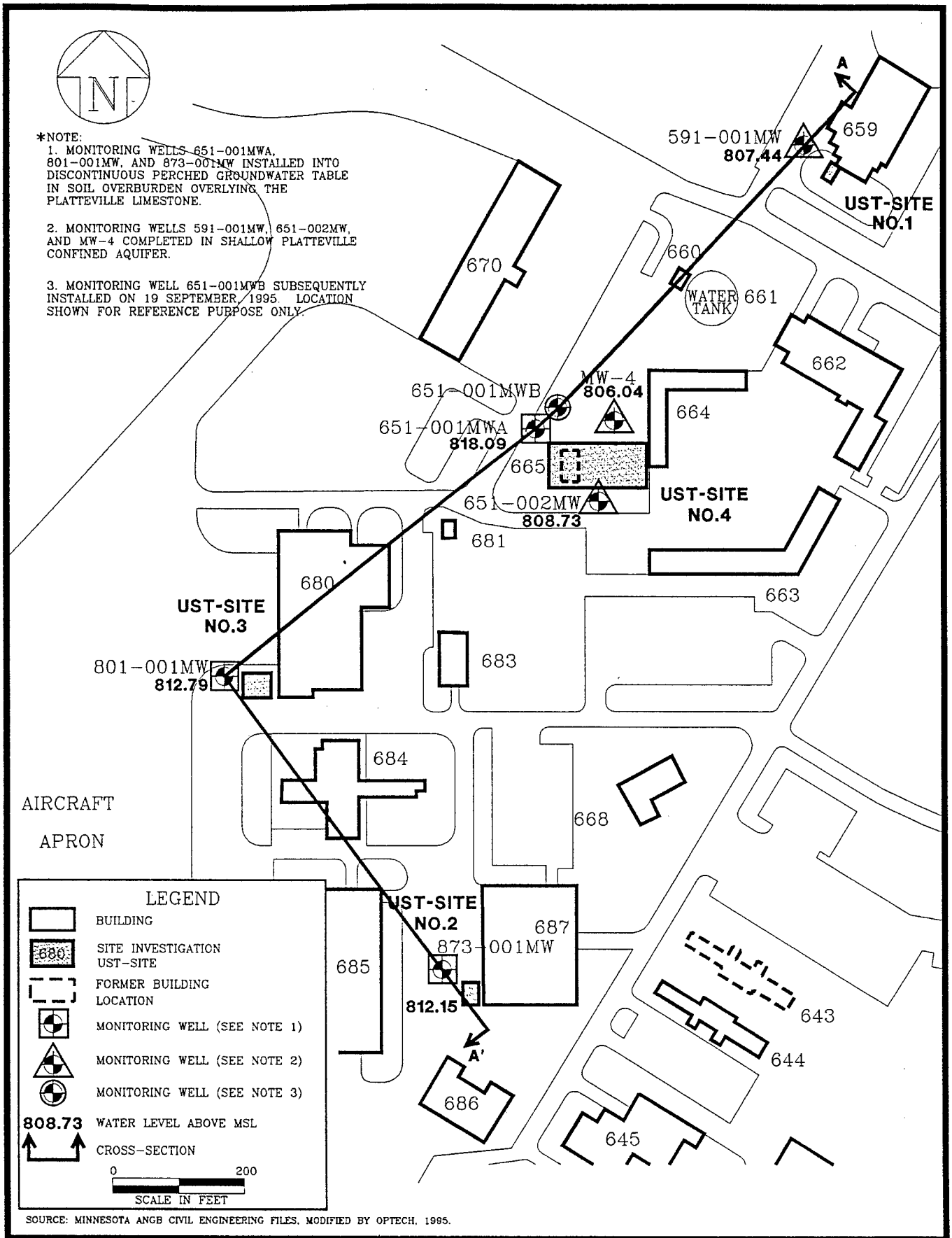
UST – Site No.	Monitoring Well ID Number	Depth (ft. BLS)	Screened Interval		Water Level[a]	
			ft. BLS	MSL	ft. BLS	MSL
1	591-001MW	30.00	18.40 - 30.00	805.40 - 793.80	17.32	806.48
2	873-001MW	10.80	4.10 - 10.10	815.69 - 808.69	7.64	811.15
3	801-001MW	11.50	3.80 - 10.80	814.62 - 807.62	6.40	812.02
4	651-001MWA	14.20	5.00 - 14.00	816.11 - 807.11	6.50	814.61
	651-001MWB	21.40	16.40 - 21.40	804.70 - 799.70	13.48	807.62
	651-002MW	25.00	15.30 - 25.00	803.65 - 793.95	11.24	807.71

ft. BLS/MSL – feet Below Land Surface/Mean Sea Level.
UST – Underground Storage Tank.
MW – Monitoring Well.
ID – Identification.
[a]Water level on 22 September 1995.

and TPH-DRO by modified WDNR method. The locations of the soil borings are presented on Figure 5.4. The laboratory reports are presented in Appendix I.

One monitoring well was installed at UST – Site No. 1, in the inferred downgradient direction from the UST excavation. The borehole of monitoring well 591-001MW was advanced approximately 12.0 feet into bedrock (30.0 feet BLS) using the air-rotary technique. Cuttings from the upper section of the bedrock were dry. Water-saturated limestone cuttings were encountered at a depth of about 10.0 feet below the bedrock/overburden contact (28.0 feet BLS). The water level rose approximately 14.0 feet in the borehole, indicating the presence of confined aquifer conditions. The potentiometric surface of the confined groundwater measured in the monitoring well on 22 September 1995 was approximately 17.3 feet BLS (806.48 feet MSL). No hydrocarbon odor or sheen was noted in groundwater samples collected from the well. Monitoring well 591-001MW was completed as an open-hole completion set into bedrock. The monitoring well construction log is included in Appendix B.

Two rounds of investigative samples were collected from the monitoring well for laboratory analyses. The well was completed on 14 August 1995 and samples collected on 16 August 1995 and 19 September 1995. Standard groundwater sampling protocols followed during the SI are described in Subsection 4.4.3. Groundwater samples were analyzed for VOCs by USEPA Method SW-846/8240 and TPH-DRO by WDNR method. The location of the monitoring well is presented on Figure 5.4. The laboratory reports are presented in Appendix I.



SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995.

FIGURE 5.1

MINNEAPO\UST-1-4

PROJECT AREA WATER-LEVEL MAP 16-17 AUGUST, 1995

133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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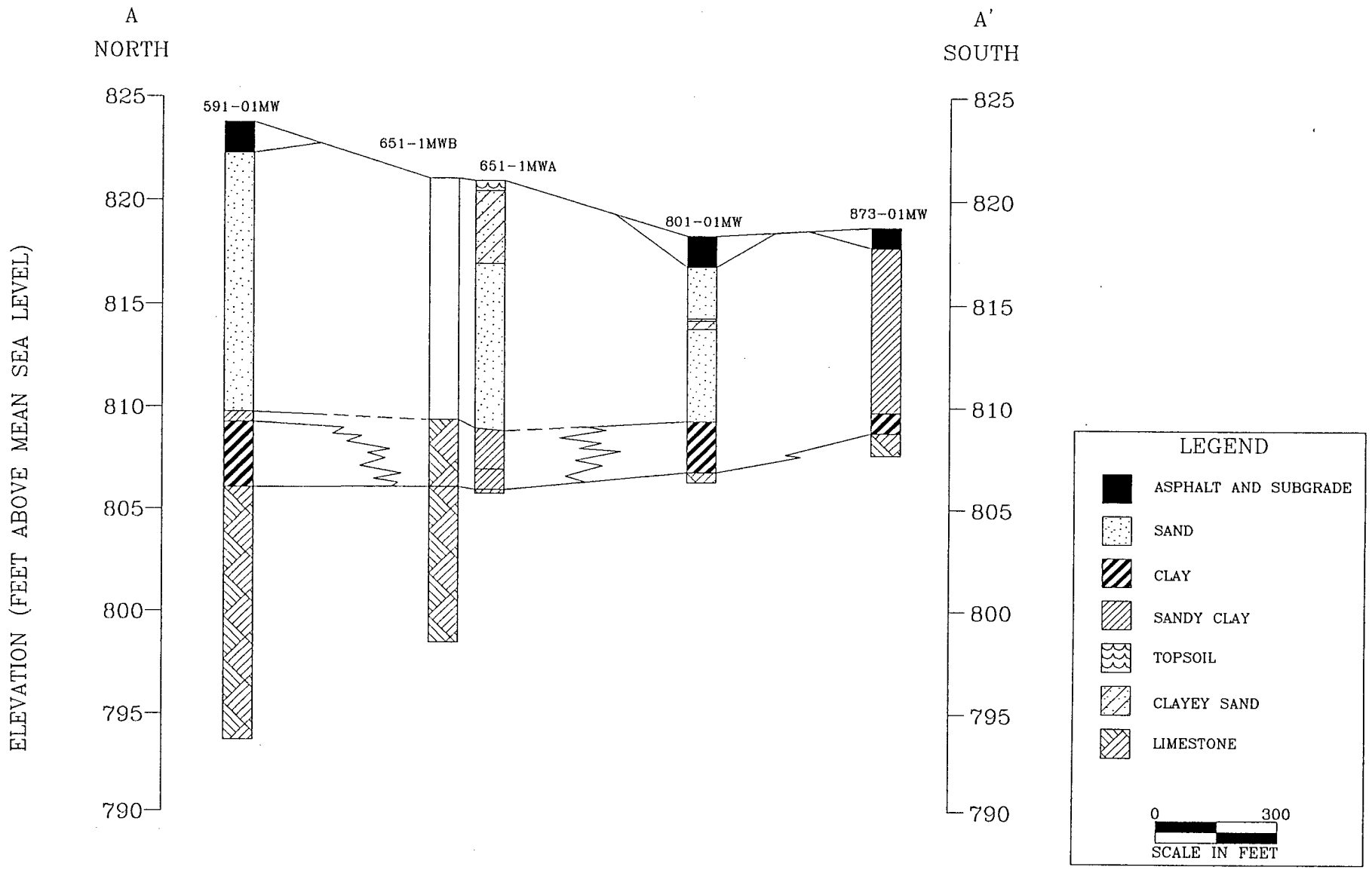

FIGURE 5.2

MINNEAPO\CROSS-AA

PROJECT AREA GEOLOGIC CROSS-SECTION A-A'

133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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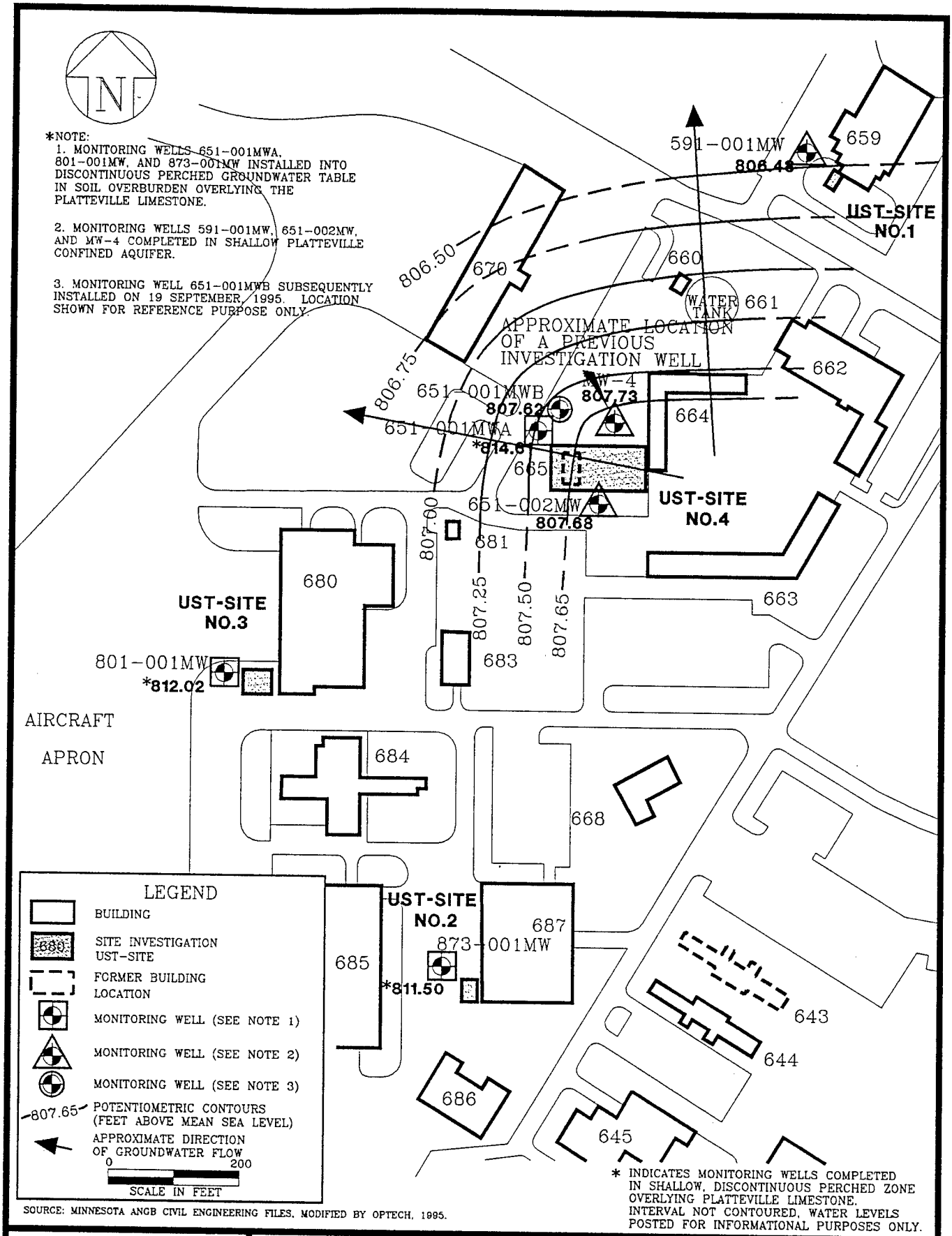

FIGURE 5.3

MINNEAPO\UST-1-4

PROJECT AREA POTENTIOMETRIC MAP
CONFINED AQUIFER-PLATTEVILLE
22 SEPTEMBER 1995
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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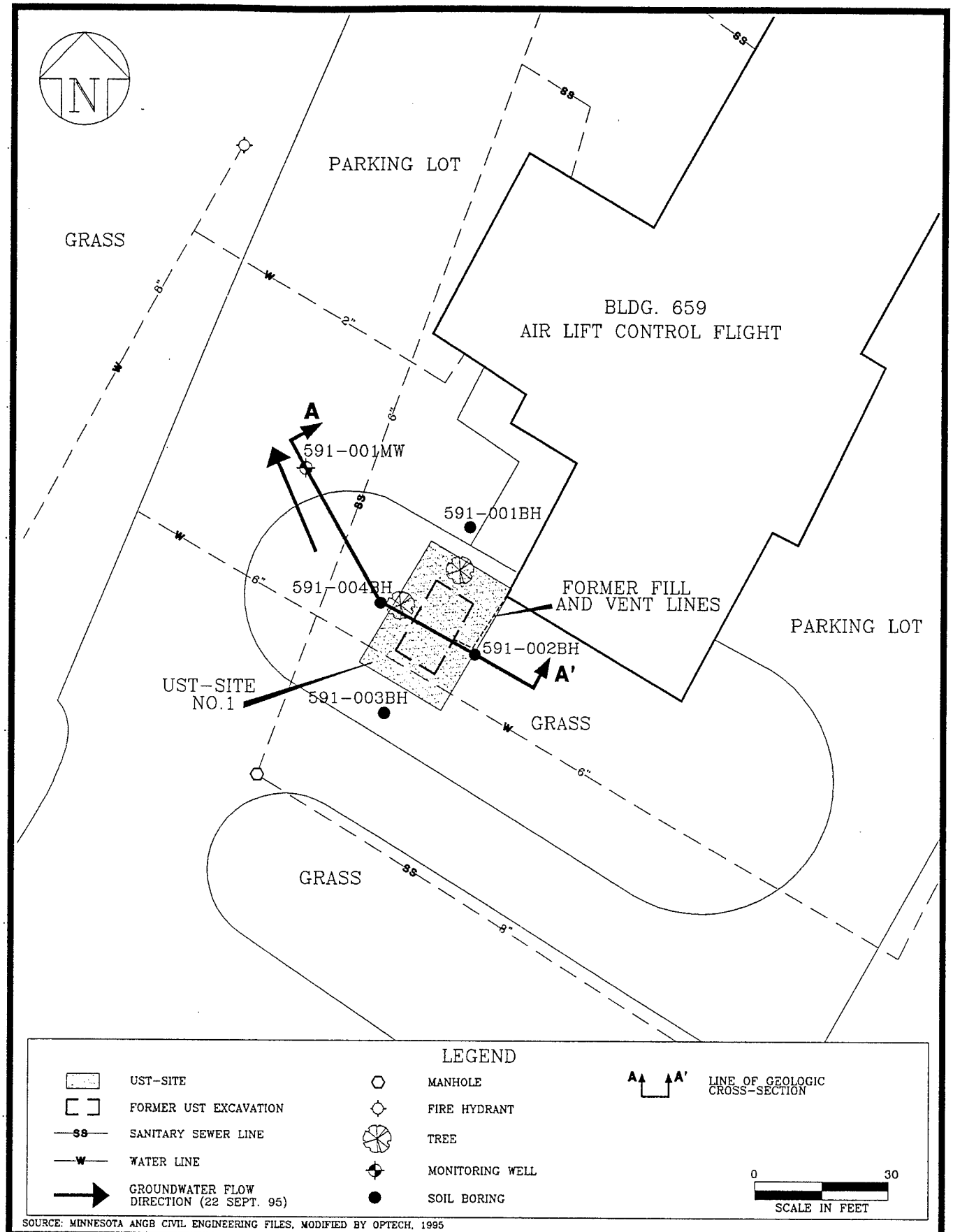

SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995

FIGURE 5.4

MINN\SITE

SITE PLAN
UST-SITE NO.1

133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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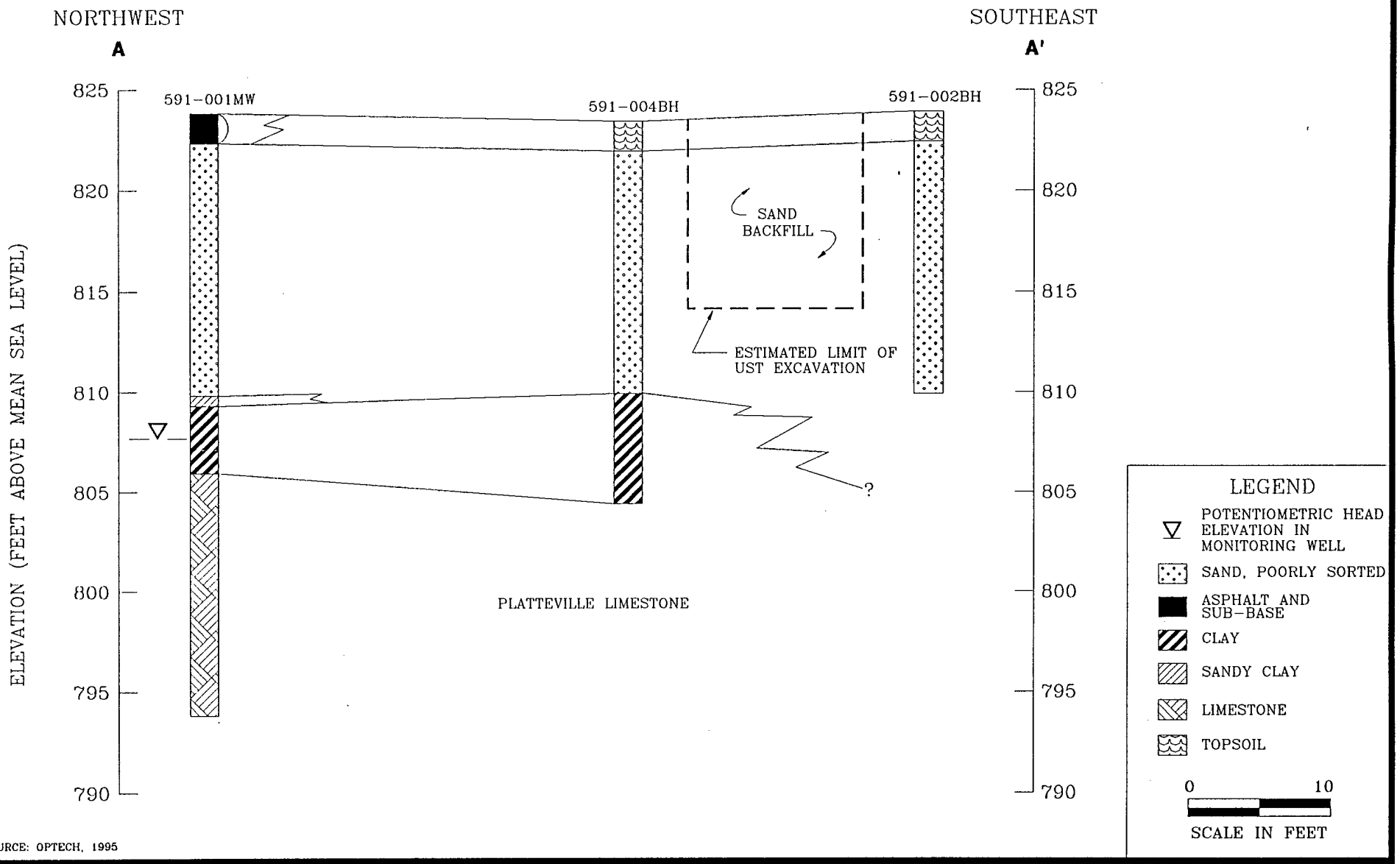
5.1.1 Site Geology and Groundwater Conditions

Geologic information obtained from soil borings and monitoring well boreholes were used to describe the subsurface geology according to ASTM method D-2488-90. Lithologic logs are presented in Appendix A, Boring Logs. The depth to groundwater encountered during drilling operations was recorded on the boring logs. The geologic cross-section depicting the subsurface geology at UST – Site No. 1 is indexed in Figure 5.4 and is presented as Figure 5.5.

The predominant lithology of the glacial deposits overlying the bedrock consists of fine- to medium-grained quartz sand with lesser amounts of gravel and silt. Approximately 3.5 feet of green clay with occasional thin lenses of limestone were encountered overlying bedrock. The depth to bedrock as indicated by auger refusal is approximately 18.5 feet BLS. The bedrock underlying the glacial deposits is the Ordovician Platteville Limestone and is composed of thin- to medium-bedded, gray and yellowish-brown dolomite and dolomitic limestone (Liesch, 1992). Thin layers of water-saturated clay and lensetic limestones were encountered just above bedrock. Insufficient amounts of groundwater were present to complete monitoring well 591-001MW in the overburden zone.

Groundwater was encountered in wells completed in the Platteville Formation (limestone) during this investigation at significantly different depths, indicating that local groundwater flow direction may be controlled by fractures. The inferred groundwater flow direction at the site, based on data from wells located across the Minneapolis International Airport, is generally to the north and northwest (Liesch, 1992). This is consistent with the groundwater flow direction based on potentiometric surface measurements made on 22 September 1995 from monitoring well 591-001MW and other monitoring wells installed within the same interval at UST – Site No. 4 (Figure 5.3). The estimated groundwater gradient at the site is 0.003 feet per foot (ft/ft).

On 20 September 1995, a rising head slug test was conducted in monitoring well 591-001MW according to procedures detailed in Section 4.6. The hydraulic conductivity value was computed from the Bouwer and Rice (1976) method for confined conditions using the AQTESOLV 2.0 Version computer program (Geraghty & Miller, Inc., 1994). The hydraulic conductivity was calculated to be 11 feet per day (ft/day) (0.0039 centimeters per second (cm/s)). The hydraulic conductivity values of the Platteville Limestone range from 1.2×10^{-3} to 6.6×10^{-4} cm/s (Liesch, 1992). The average linear groundwater velocity in the Platteville limestone beneath the site is estimated at 60 feet per year (ft/yr). The hydrologic unit effective porosity is estimated to be 20 percent (Freeze and Cherry, 1979).



SOURCE: OPTECH, 1995

FIGURE 5.5

GEOLOGIC CROSS-SECTION A-A'
UST-SITE NO.1
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

MINNEAPO\AA-591

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5.1.2 Soil and Groundwater Field Screening Results

Twenty-seven subsurface soil samples and one groundwater sample were field screened for BTEX compounds with the Photovac 10S+ Portable GC as described in Section 4.3. Table 5.3 summarizes the maximum concentrations of BTEX components detected by field screening in soil and groundwater samples collected at UST – Site No. 1. The field screening results are summarized in Table 5.3. Complete field GC data for all samples are presented in Appendix C.

Benzene and toluene were detected at maximum concentrations of 60 parts per billion (ppb) and 24 ppb, respectively, from a soil sample collected from soil boring 591-004BH at the 18.5- to 19.0-foot interval. Ethylbenzene and total xylenes were detected at maximum concentrations of 7 ppb and 27 ppb, respectively, from a soil sample collected from monitoring well borehole 591-001MW at the 2.0- to 3.0-foot interval.

Benzene was detected in the groundwater sample collected from monitoring well 591-001MW at a concentration of 3 ppb. Toluene, ethylbenzene, and total xylenes were not detected above the detection limit of 1 ppb.

5.1.3 Soil Contamination

Analytical results for BTEX and TPH-DRO detected in soil samples collected at UST – Site No. 1 are presented in Table 5.4. Benzene and toluene were detected in one soil sample collected from soil boring 591-004BH at the 18.5- to 19.0-foot interval at concentrations of 2 micrograms per kilogram (μg/kg) and 3 μg/kg, respectively. Total xylenes were detected at a maximum concentration of 2 μg/kg in a soil sample collected from soil boring 591-002BH at the 13.5- to 14.0-foot interval. Ethylbenzene was not detected in any soil samples. TPH-DRO was detected at a concentration of 4.1 mg/kg in a soil sample collected from soil boring 591-003BH at the 14.0- to 15.0-foot interval (Figure 5.6).

5.1.4 Groundwater Contamination

No BTEX constituents were detected in the groundwater samples collected at UST – Site No. 1. Analytical results for TPH-DRO detected in groundwater samples collected at UST – Site No. 1 are presented in Table 5.5 and Figure 5.7. TPH-DRO was detected in both groundwater sampling events at concentrations of 0.36 milligrams per liter (mg/L) and 0.30 mg/L, respectively.

Table 5.3
Results of Soil and Groundwater Field Screening for UST – Site No. 1
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

Sample Location Number	Matrix	Sample Depth (ft. BLS)	Maximum ATHA Readings (ppm)	Field GC Screening			
				Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	Total Xylenes (ppb)
591-001BH	Soil	2.0 - 3.0	1.1	1	3	6	15
591-001BH	Soil	4.0 - 5.0	0.3	2	1	ND	ND
591-001BH	Soil	9.0 - 10.0	0	1	1	ND	ND
591-001BH	Soil	13.5 - 14.5	0	1	1	1	ND
591-001BH	Soil	16.5 - 17.5	0	2	ND	1	ND
591-002BH	Soil	0.5 - 1.5	0	ND	ND	ND	ND
591-002BH	Soil	4.0 - 5.0	0	2	ND	ND	ND
591-002BH	Soil	9.0 - 10.0	0	2	ND	ND	ND
591-002BH	Soil	13.5 - 14.0	0	3	ND	2	ND
591-003BH	Soil	0.5 - 1.5	0	3	ND	ND	ND
591-003BH	Soil	4.0 - 5.0	0	3	ND	ND	ND
591-003BH	Soil	9.0 - 10.0	0	3	ND	2	ND
591-003BH	Soil	14.0 - 15.0	0	4	ND	ND	ND
591-004BH	Soil	0.5 - 1.5	0	2	ND	ND	ND
591-004BH	Soil	4.0 - 5.0	0	2	1	ND	ND
591-004BH	Soil	9.0 - 10.0	0	2	ND	ND	ND
591-004BH	Soil	13.5 - 14.5	0	2	ND	ND	ND
591-004BH	Soil	15.5 - 16.5	0	11	ND	2	ND
591-004BH	Soil	18.5 - 19.0	0	60	24	ND	ND
591-001MW	Soil	2.0 - 3.0	0	6	3	7	27
591-001MW	Soil	4.0 - 5.0	0	1	1	ND	ND
591-001MW	Soil	9.0 - 10.0	0	1	1	ND	ND
591-001MW	Soil	14.0 - 15.0	0	2	1	2	ND
591-001MW	Soil	18.0 - 20.0	0.5	7	3	5	15
591-001MW	Soil	20.0 - 22.0	0	1	2	ND	ND
591-001MW	Soil	22.0 - 24.0	0	1	3	1	ND
591-001MW	Soil	26.0 - 28.0	0	ND	1	ND	ND
591-001MW	Soil	28.0 - 30.0	0	ND	1	2	8
591-001MW	Water	–	–	3	ND	ND	ND

ft. BLS – feet Below Land Surface.
BH – Borehole.
MW – Monitoring Well.
UST – Underground Storage Tank.
GC – Gas Chromatograph.
ppb – parts per billion.
ppm – parts per million.
PID – Photoionization Detector.
ATHA – Ambient Temperature Headspace Analysis.

Table 5.4
Results of BTEX and TPH-DRO Analyses for Soil Samples Collected at UST – Site No. 1 133rd AW, Minnesota ANGB, Minneapolis, Minnesota

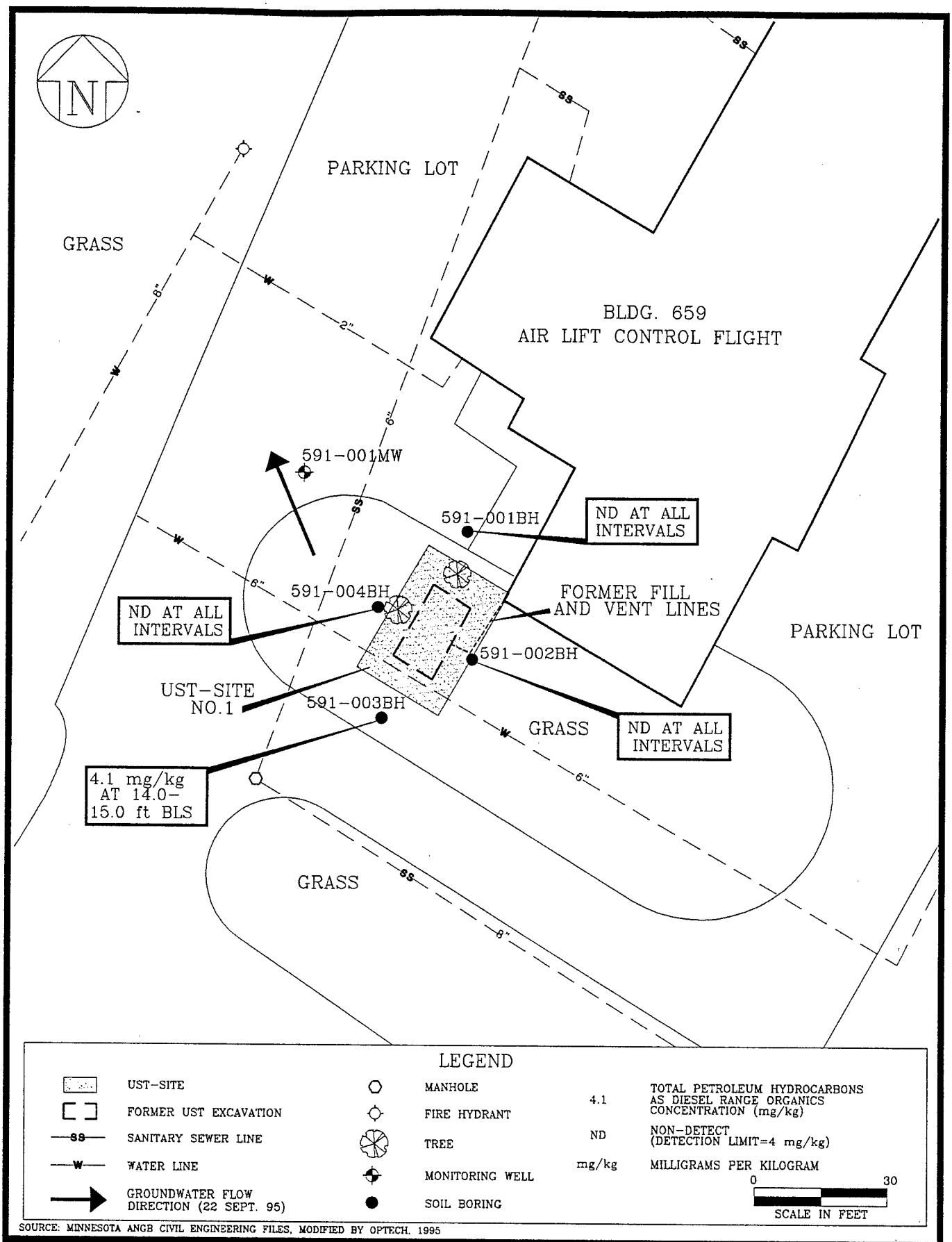
Sample ID/Interval (ft. BLS)	Sample Date	TPH-DRO (mg/kg)	Benzene (µg/kg)	Toluene (µg/kg)	Ethylbenzene (µg/kg)	Total Xylenes (µg/kg)
591-001BH 2.0 - 3.0	7 Aug 95	4U	1U	1U	1U	1
591-001BH 13.5 - 14.5	7 Aug 95	4U	1U	1U	1U	1U
591-002BH 0.5 - 1.5	7 Aug 95	4U	1U	1U	1U	1U
591-002BH 13.5 - 14.0	7 Aug 95	4U	1U	1U	1U	2
591-003BH 4.0 - 5.0	7 Aug 95	4U	1U	1U	1U	1U
591-003BH 9.0 - 10.0	7 Aug 95	4U	1U	1U	1U	1U
591-003BH 14.0 - 15.0	7 Aug 95	4.1	1U	1U	1U	1U
591-004BH DUP 8.5 - 9.0	7 Aug 95	4U	1U	1U	1U	1U
591-004BH 9.0 - 10.0	7 Aug 95	4U	1U	1U	1U	1U
591-004BH 18.5 - 19.0	7 Aug 95	4U	2	3	1U	1
591-001 FB	7 Aug 95	0.1U*	1U*	1U*	1U*	1U*
591-001 EB	7 Aug 95	0.1U*	1U*	1U*	1U*	1U*
Trip Blank	7 Aug 95	NA	1U*	1U*	1U*	1U*

U – Compound was analyzed for but was not detected. Detection limit is shown.
TPH-DRO – Total Petroleum Hydrocarbons-Diesel Range Organics.
BH – Borehole.
UST – Underground Storage Tank.
ft. BLS – feet Below Land Surface.
ID – Identification.
µg/kg – micrograms per kilogram.
mg/kg – milligrams per kilogram.
FB – Aqueous Field Blank.
EB – Aqueous Equipment Rinseate Blank.
NA – Not Analyzed.
DUP – Duplicate.
* – micrograms per liter.

Table 5.5
Results of TPH-DRO Analyses for Groundwater Samples Collected at UST – Site No. 1 133rd AW, Minnesota ANGB, Minneapolis, Minnesota

Sample ID	Sample Date	TPH-DRO (mg/L)
591-001MW	16 Aug 95	0.36
Trip Blank	16 Aug 95	NA
591-001MW	19 Sep 95	0.30
591-Equipment Blank	19 Sep 95	0.1U
Trip Blank-1	19 Sep 95	NA

U – Compound was analyzed for but was not detected. Detection limit is shown.
TPH-DRO – Total Petroleum Hydrocarbons-Diesel Range Organics.
MW – Monitoring Well.
UST – Underground Storage Tank.
ID – Identification.
NA – Not Analyzed.
mg/L – milligrams per liter.



SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995

FIGURE 5.6

MINN\SITE

TPH-DRO DETECTED IN SOIL (ALL DEPTHS) UST-SITE NO.1

133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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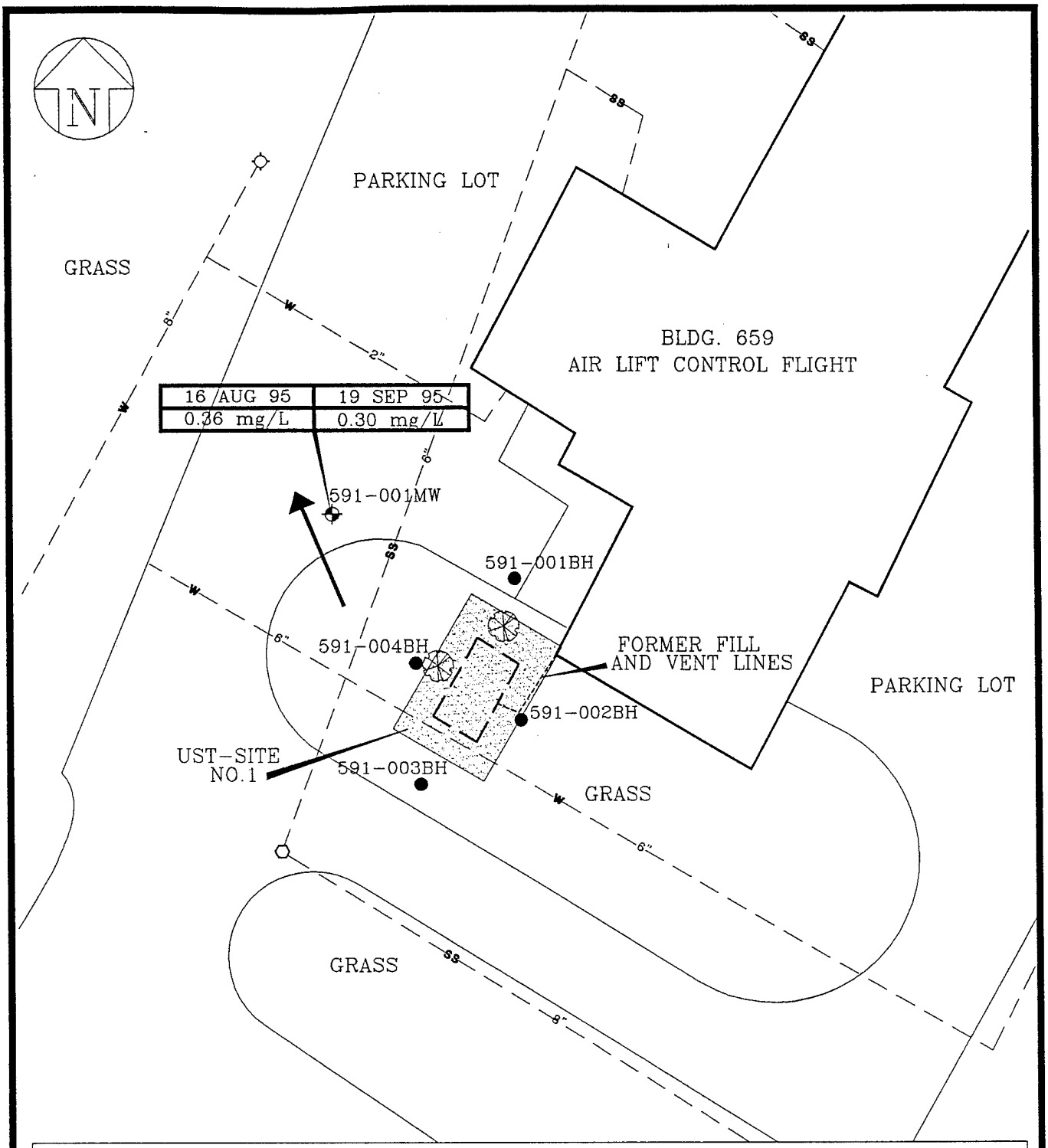
MAY 1996



SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995

FIGURE 5.7

MINN\SITE

TPH-DRO DETECTED IN GROUNDWATER
UST-SITE NO.1

133rd AW, Minnesota ANGB
Minneapolis, Minnesota

OPTECH
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MAY 1996

5.1.5 Conclusions

No BTEX compounds were detected in soil samples collected from the UST excavation during Bay West, Inc.'s, August 1993 UST removal activities. TPH-DRO was detected at a concentration of 1,300 mg/kg during the UST removal activities in one soil sample collected from the UST excavation floor at a depth of 10.0 feet BLS and at 280 mg/kg in one soil sample collected from the vent piping run at a depth of 2.0 feet BLS. No groundwater was encountered in the UST excavation.

During the August 1995 SI, BTEX compounds were found in three investigative soil samples collected from the delineation soil borings in trace amounts ranging from 1 to 3 μg/kg. TPH-DRO was detected in one soil sample at a concentration of 4.1 mg/kg (detection limit of 4 mg/kg). The levels of BTEX and TPH-DRO contamination detected during the SI are not considered to be harmful of human health or the environment.

Based on the delineation results of the SI, soil contamination at levels of concern consists of residual concentrations of low volatile compounds (TPH-DRO) localized to one section of the UST excavation floor and along the former vent piping run. Significant contaminant migration is not apparent.

Analysis of groundwater samples collected from monitoring well 591-001MW, located downgradient of the UST excavation, exhibited a maximum TPH-DRO concentration of 0.36 mg/L. No MDH HRLs for drinking water have been established for TPH-DRO.

Based on the results of groundwater analyses conducted during the SI, minimal groundwater impact from TPH-DRO has occurred at the site. The levels of TPH-DRO detected in the groundwater samples are generally not considered to be harmful to human health or the environment.

5.1.6 Recommendations

Based on the results of previous investigations and this SI, no further investigative or remedial actions for soil and groundwater are warranted. Site closure should be requested from the MPCA.

5.2 UST – SITE NO. 2 (FORMER UST 873) – MPCA LEAK NO. 6685 INVESTIGATIVE FINDINGS

Three soil borings were drilled at UST – Site No. 2 for collection of seven soil samples for laboratory analyses. Soil samples were analyzed for VOCs by USEPA Method SW-846/8240 and TPH-DRO by modified WDNR method. Standard soil sampling protocols used are described in Subsection 4.4.3. The locations of the soil borings are presented on Figure 5.8. The laboratory reports are presented in Appendix I.

One monitoring well was installed at UST – Site No. 2, in the inferred downgradient direction from the UST excavation. Monitoring well 873-001MW was installed in the soil overburden to an approximate depth of 10.8 feet BLS. The monitoring well is located in the inferred downgradient direction from the UST excavation. The term "inferred" groundwater flow direction refers to the assumed groundwater flow based on previous investigations in the area but may not reflect actual site conditions. The potentiometric surface of the confined groundwater, as measured in the monitoring well on 22 September 1995, was approximately 7.64 feet BLS (811.15 feet MSL). No hydrocarbon odor or sheen was noted in groundwater samples collected from the well. The monitoring well construction log is included in Appendix B. Information on well depth, screened interval, and water level is summarized in Table 5.2.

Two rounds of groundwater samples were collected for laboratory analyses. The well was installed on 11 August 1995 and groundwater samples were collected on 16 August 1995 and 19 September 1995. Standard groundwater sampling protocols used are described in Subsection 4.4.3. Groundwater samples were analyzed for VOCs by USEPA Method SW-846/8240 and TPH-DRO by modified WDNR method. The locations of the monitoring wells are presented on Figure 5.8. The laboratory reports are presented in Appendix I.

5.2.1 Site Geology and Groundwater Conditions

Geologic information obtained from soil borings and monitoring well boreholes were used to describe the subsurface geology according to ASTM method D-2488-90. Lithologic logs are presented in Appendix A, Boring Logs. The depth to groundwater encountered during drilling operations was recorded on the boring logs. The geologic cross-section depicting the subsurface geology at UST – Site No. 2 is indexed in Figure 5.8 and is presented as Figure 5.9.

The predominant lithology of the glacial deposits overlying the bedrock consists of fine- to medium-grained poorly sorted quartz sand and sandy clay. Approximately one foot of green

clay, with occasional thin lenses of limestone, were encountered overlying bedrock. The depth to bedrock as indicated by auger refusal is approximately 10.0 feet BLS. The bedrock underlying the glacial deposits is the Ordovician Platteville Limestone and is composed of thin- to medium-bedded, gray and yellowish-brown dolomite and dolomitic limestone (Liesch, 1992). Thin layers of clay and lensetic limestones were encountered just above bedrock in some borings.

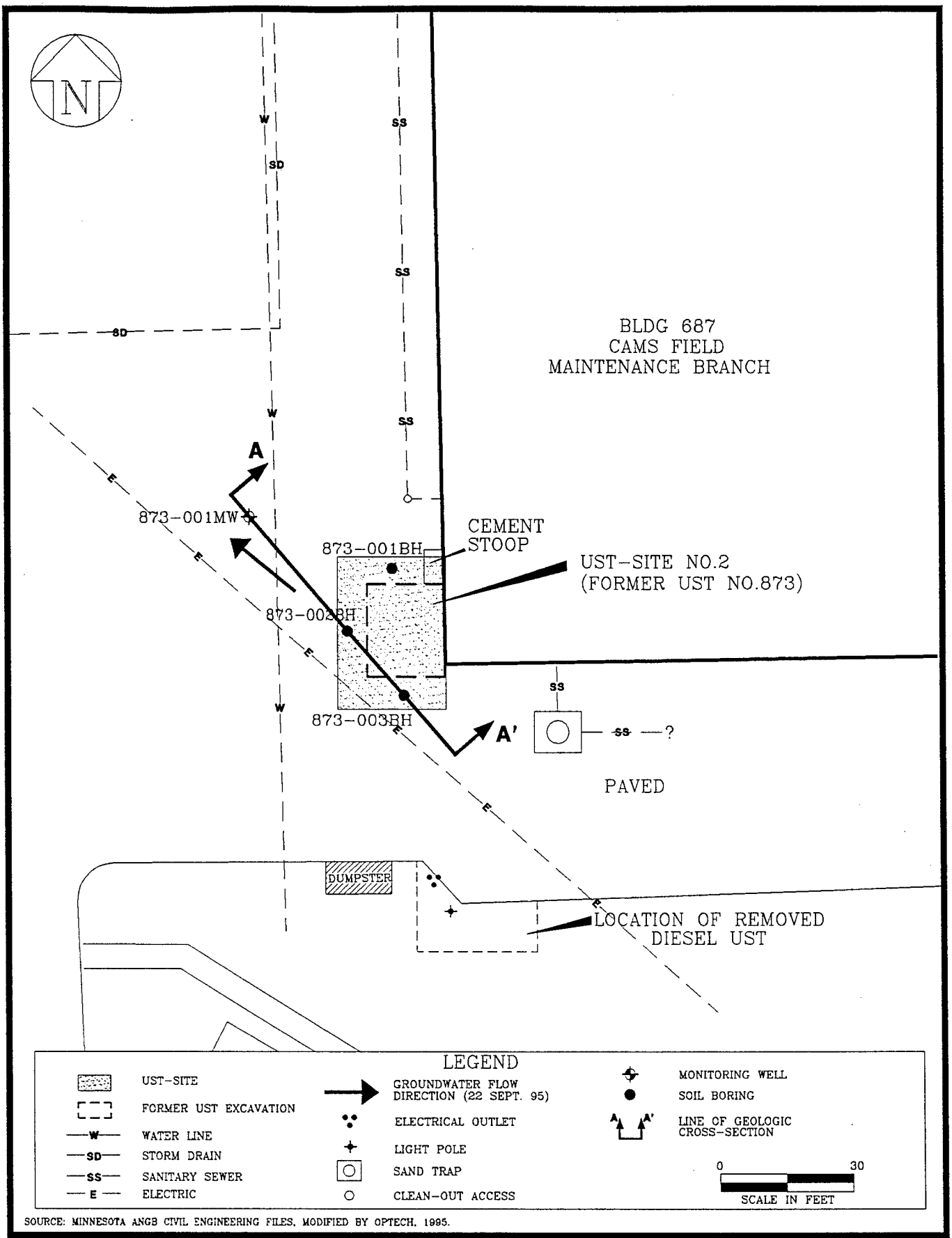
Due to the apparent discontinuous nature of groundwater perched above the Platteville Formation, no definitive groundwater flow direction can be estimated based on water level measurements in monitoring wells installed in the shallow perched zone during the SI at the other UST sites (Figure 5.1). The inferred groundwater flow direction in the vicinity of the Minneapolis International Airport is generally to the north and northwest (Liesch, 1992).

On 20 September 1995, a rising head slug test was conducted in monitoring well 873-001MW according to procedures detailed in Section 4.6. The hydraulic conductivity value was computed from the Bouwer and Rice (1976) method for unconfined conditions using the AQTESOLV 2.0 Version computer program (Geraghty & Miller, Inc., 1994). The hydraulic conductivity was calculated to be 220 feet per day (ft/day).

5.2.2 Soil and Groundwater Sample Field Screening Results

Twelve subsurface soil samples and one groundwater sample were field screened for BTEX compounds with the Photovac 10S+ Portable GC as described in Section 4.3. The field screening results are summarized in Table 5.6. Complete field GC data for all samples are presented in Appendix C.

Benzene was detected in all but one of the soil samples collected from the soil borings and from the monitoring well borehole at a maximum concentration of 3 ppb. Toluene and total xylenes were detected in soil samples collected from soil boring 873-002BH and from monitoring well borehole 873-001MW at maximum concentrations of 4 ppb and 44 ppb, respectively. Ethylbenzene was detected in soil samples collected from soil borings 873-001BH and 873-002BH at a maximum concentration of 11 ppb.



SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995.

FIGURE 5.8

MINN\SITE-873

SITE PLAN
UST-SITE NO.2
LOCATION MAP

133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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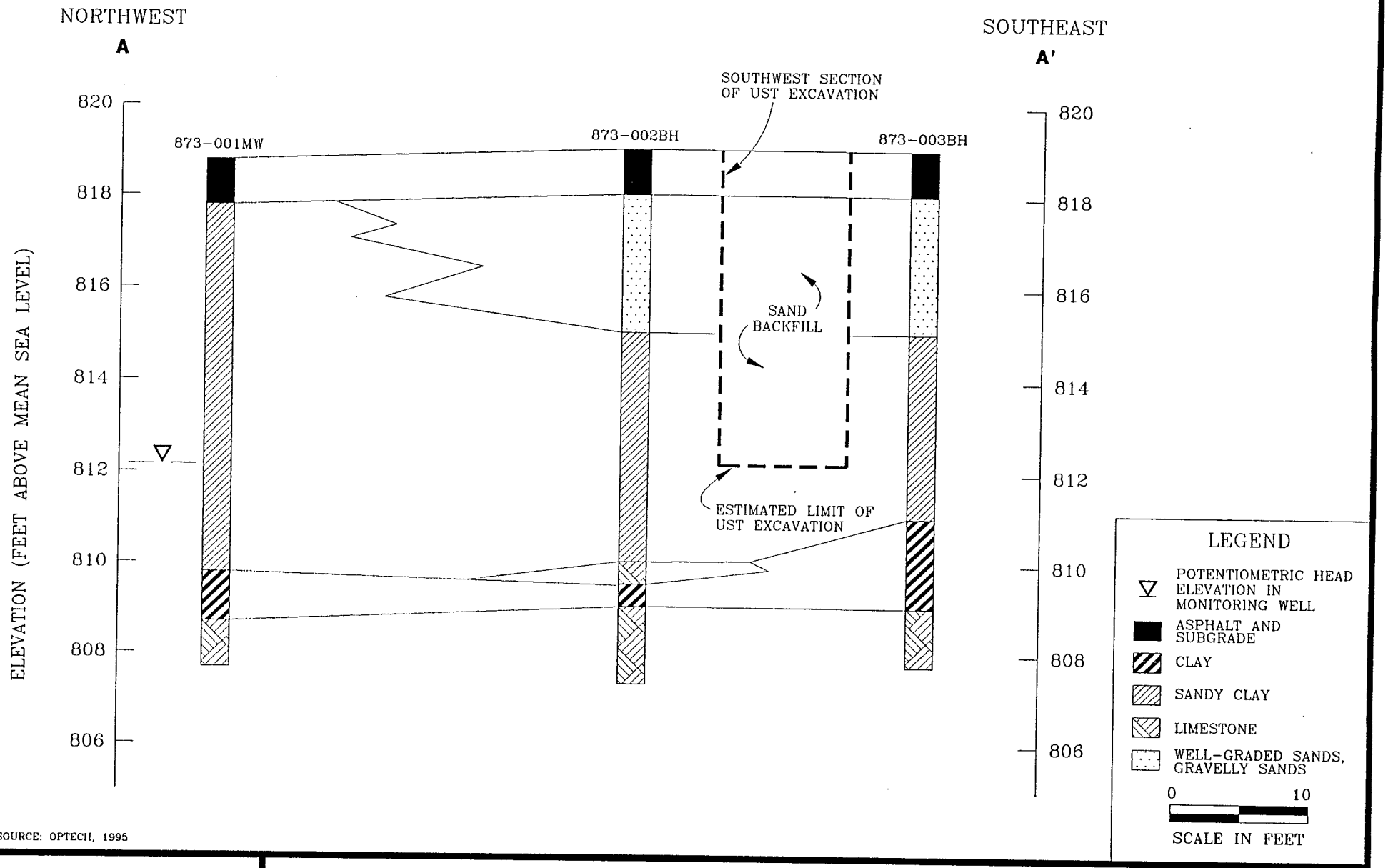

SOURCE: OPTECH, 1995

FIGURE 5.9

MINNEAPO\AA-873

GEOLOGIC CROSS-SECTION A-A'
UST-SITE NO.2
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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Table 5.6
Results of Soil and Groundwater Field Screening for UST – Site No. 2
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

Sample Location Number	Matrix	Sample Depth (ft. BLS)	Maximum ATHA Readings (ppm)	Field GC Screening			
				Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	Total Xylenes (ppb)
873-001BH	Soil	1.5 - 2.5	0	3	ND	2	ND
873-001BH	Soil	4.0 - 5.0	0	3	ND	4	ND
873-001BH	Soil	9.0 - 10.0	0	3	ND	4	ND
873-002BH	Soil	1.5 - 2.5	2.1	1	1	1	ND
873-002BH	Soil	4.0 - 5.0	0	3	4	11	44
873-002BH	Soil	9.0 - 10.0	0.3	2	ND	ND	ND
873-003BH	Soil	1.5 - 2.5	0	1	ND	ND	ND
873-003BH	Soil	4.0 - 5.0	0	1	ND	ND	ND
873-003BH	Soil	9.0 - 10.0	0	1	ND	ND	ND
873-001MW	Soil	2.0 - 3.0	0	1	1	ND	6
873-001MW	Soil	4.0 - 5.0	0	ND	ND	ND	6
873-001MW	Soil	9.0 - 10.0	0	3	ND	ND	13
873-001MW	Water	–	–	3	1	ND	ND

ft. BLS – feet Below Land Surface.
BH – Borehole.
MW – Monitoring Well.
UST – Underground Storage Tank.
GC – Gas Chromatograph.
ppb – parts per billion.
ppm – parts per million.
PID – Photoionization Detector.
ATHA – Ambient Temperature headspace Analysis.

Benzene and toluene were detected in a groundwater sample collected from monitoring well 873-001MW at concentrations of 3 ppb and 1 ppb, respectively. Ethylbenzene and total xylenes were not detected in the groundwater sample.

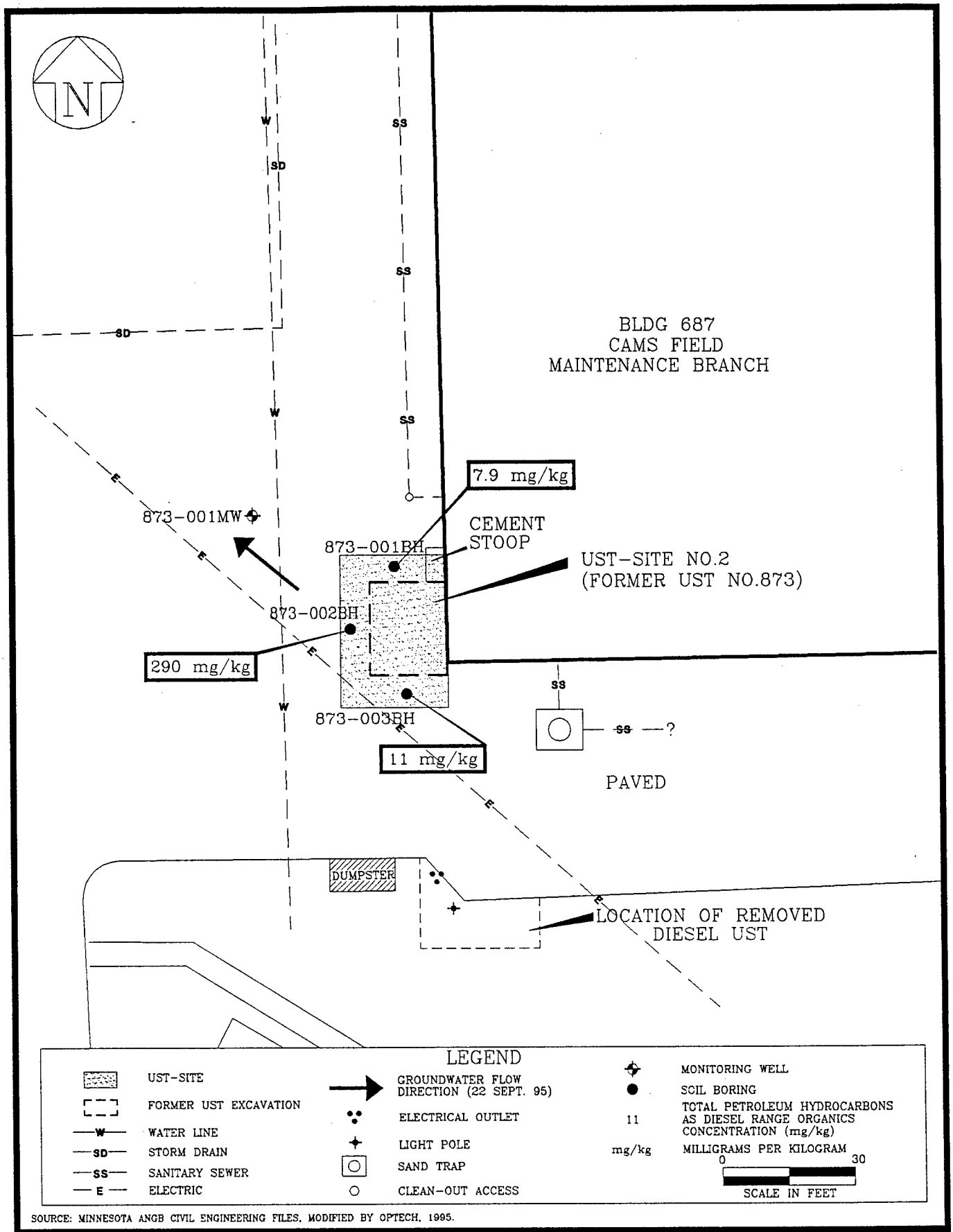
5.2.3 Soil Contamination

Analytical results for VOCs and TPH-DRO detected in soil samples are presented in Table 5.7. No VOCs were detected in soil samples collected at UST – Site No. 2. TPH-DRO was detected in all soil samples submitted for laboratory analysis, with a maximum concentration of 290 mg/kg in the soil sample collected from soil boring 873-002BH at the 1.5- to 2.5-foot interval (Figures 5.10 and 5.11).

Table 5.7
Results of VOCs and TPH-DRO Analyses
for Soil Samples Collected at UST – Site No. 2
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

Sample ID/Interval (ft. BLS)	Sample Date	TPH-DRO (mg/kg)	VOCs (µg/kg)
873-001BH 4.0 - 5.0	8 Aug 95	7.9	5U
873-001BH 9.0 - 10.0	8 Aug 95	7.4	5U
873-001BH FB	8 Aug 95	1.0U	5U
Trip Blank	8 Aug 95	NA	5U
873-002BH 1.5 - 2.5	9 Aug 95	290	5U
873-002BH 9.0 - 10.0	9 Aug 95	18	5U
873-002BH 9.0 - 10.0 DUP	9 Aug 95	9.8	5U
873-003BH 4.0 - 5.0	9 Aug 95	11	5U
873-003BH 9.0 - 10.0	9 Aug 95	8.4	5U
873-001 EB	9 Aug 95	0.1U	5U
Trip Blank	9 Aug 95	NA	5U

U – Compound was analyzed for but was not detected. Detection limit is shown.
BH – Borehole.
UST – Underground Storage Tank.
ft. BLS – feet Below Land Surface.
ID – Identification.
µg/kg – micrograms per kilogram.
mg/kg – milligrams per kilogram.
EB – Aqueous Equipment Rinseate Blank.
FB – Aqueous Field Blank.
DRO – Diesel Range Organics.
DUP – Duplicate.
Note: Standard SW8240 compounds analyzed for. No VOCs detected.



SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995.

FIGURE 5.10

MINN\SITE-873

TPH-DRO DETECTED IN SOIL SAMPLES
(0.0-5.0 ft BLS) UST-SITE NO.2

133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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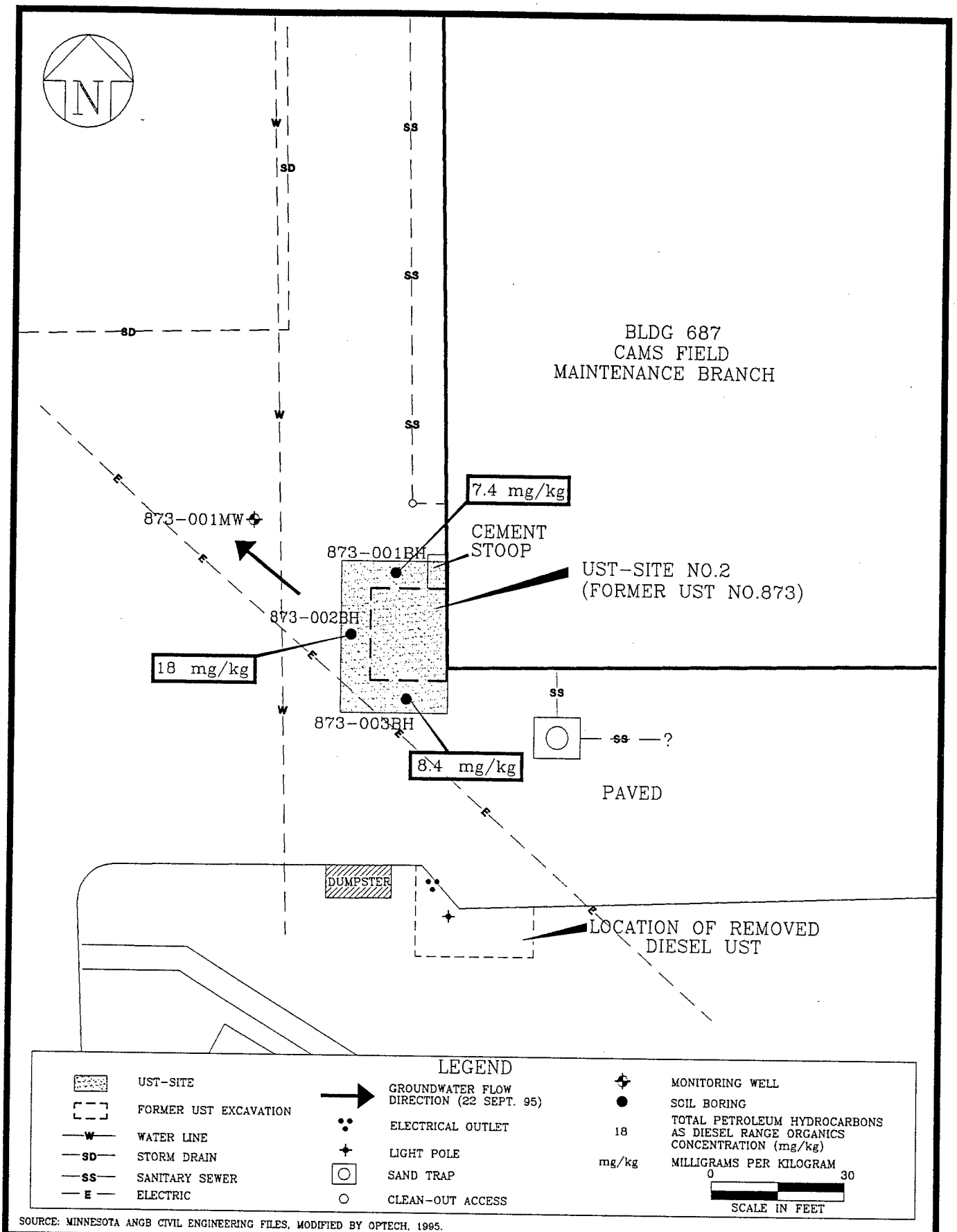

SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995.

FIGURE 5.11

MINN\SITE-873

TPH-DRO DETECTED IN SOIL SAMPLES
(9.0-10.0 ft BLS) UST-SITE NO.2

133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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MAY 1996

5.2.4 Groundwater Contamination

Analytical results for VOCs and TPH-DRO detected in groundwater samples are presented in Table 5.8. No VOCs were detected in the groundwater samples collected at UST – Site No. 2.

Table 5.8
Results of TPH-DRO and VOC Analyses for
Groundwater Samples Collected at UST – Site No. 2
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

Sample ID	Sample Date	TPH-DRO (mg/L)	VOCs (µg/L)
873-001MW	16 Aug 95	0.11	5U
873-GW FB	16 Aug 95	0.1U	5U
873-001MW	19 Sept 95	0.1U	5U

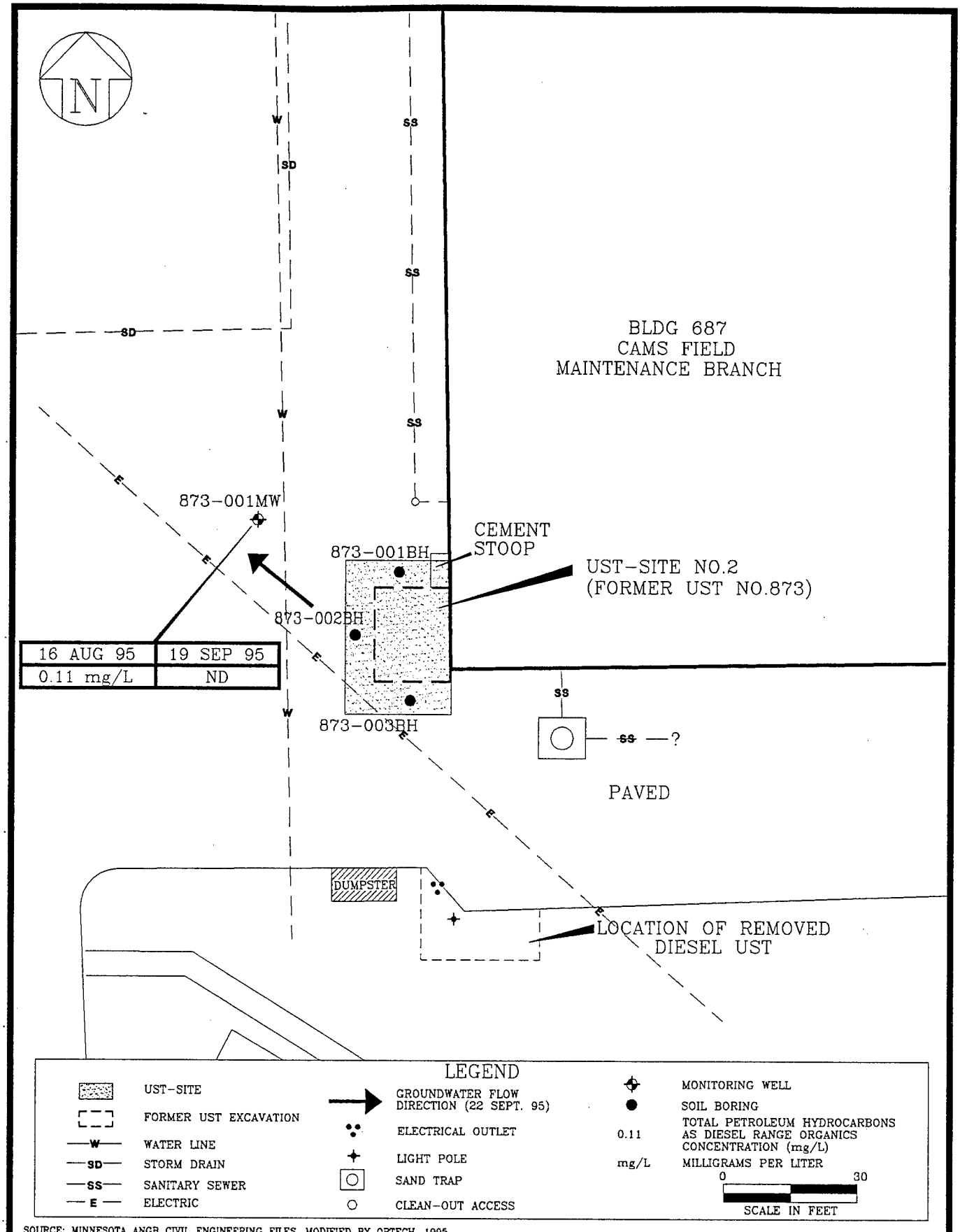
U – Compound was analyzed for but was not detected. Detection limit is shown.
MW – Monitoring Well.
UST – Underground Storage Tank.
ft. BLS – feet Below Land Surface.
ID – Identification.
µg/L – micrograms per liter.
mg/L – milligrams per liter.
TPH-DRO – Total Petroleum Hydrocarbons-Diesel Range Organics.
DUP – Duplicate.
VOCs – Volatile Organic Compounds.

TPH-DRO was detected only in the groundwater sample taken during the 16 August 1995 sampling round, at a concentration of 0.11 mg/L (Figure 5.12).

5.2.5 Conclusions

No VOCs were detected in soil samples collected from the UST excavation during Bay West, Inc.'s, August 1993 UST removal activities. TPH-DRO was detected at a concentration of 24 mg/kg during the UST removal activities in one soil sample collected from the north sidewall of the UST excavation floor at a depth of 7.0 feet BLS and at 9 mg/kg in one soil sample collected from the south sidewall at a depth of 6.5 feet BLS.

During the August 1995 SI, no VOCs were detected in the six investigative soil samples collected from the delineation soil borings. TPH-DRO was detected at a concentration of 290 mg/kg in the near-surface (1.5 to 2.5 feet BLS) soil sample collected from soil boring 873-001BH. TPH-DRO detected in soil samples from all other sample intervals ranged from 7.4 to 18 mg/kg.



SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995.

FIGURE 5.12

MINN\SITE-873

TPH-DRO DETECTED IN GROUNDWATER SAMPLES UST-SITE NO.2

133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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Based on the delineation results of the SI, soil contamination at levels of concern exists as residual concentrations of low volatile compounds (TPH-DRO) at a depth of approximately 2.0 feet BLS, near the north edge of the UST excavation. Vertical delineation of the TPH-DRO indicates that the elevated concentrations are restricted to the upper few feet of the soil profile, underneath the asphalt paving and subgrade. TPH-DRO concentrations decrease rapidly with depth within the soil profile to 18 mg/kg or less. Based on the distribution and magnitude of TPH-DRO contamination, the potential for significant impact to groundwater is low.

A water sample collected directly from the UST excavation during the Bay West, Inc., August 1993 removal activities exhibited a total VOC concentration of 1,194 μg/L and TPH-DRO concentration of 0.45 mg/L. The contamination detected in the water sample represents contact of groundwater with contaminated materials within the UST excavation and cannot be considered representative of groundwater conditions in native soils at the site.

Analyses of the first round (16 August 1995) of groundwater samples collected from monitoring well 873-001MW, located in the inferred downgradient direction from the UST excavation, exhibited a maximum TPH-DRO concentration of 0.11 mg/L (detection limit of 0.1 mg/L). No TPH-DRO was detected in groundwater samples collected from the monitoring well during the second round (19 September 1995) of groundwater sampling.

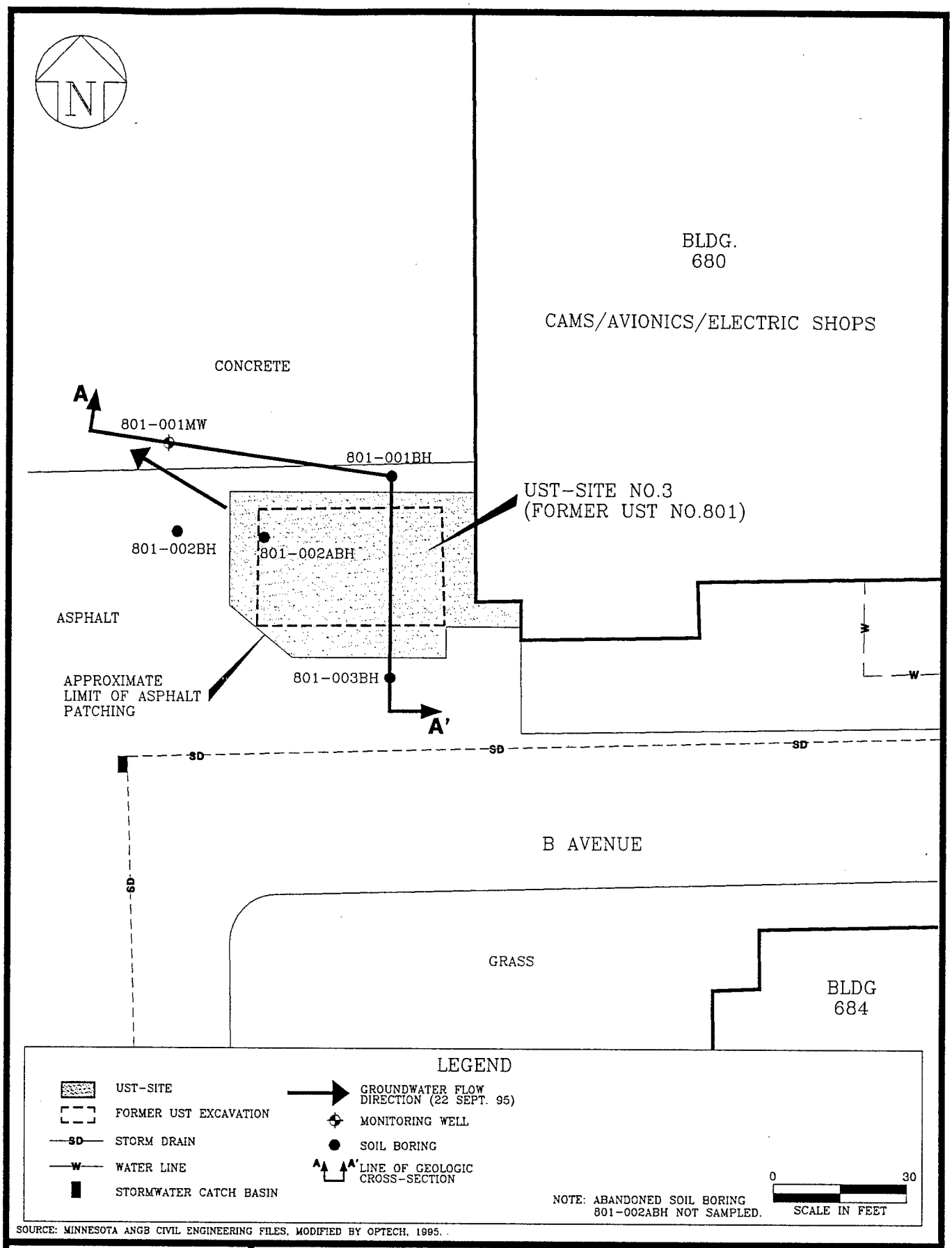
Based on the results of groundwater analyses conducted during the SI, no groundwater contamination has been confirmed outside of the UST excavation at the site.

5.2.6 Recommendations

Based on the results of previous investigations and this SI, no further investigative or remedial actions outside of the UST excavation are warranted. Site closure should be requested from the MPCA.

5.3 UST – SITE NO. 3 (FORMER UST 801) – MPCA LEAK NO. 6621 INVESTIGATIVE FINDINGS

Three soil borings were drilled at UST – Site No. 3 for collection of seven soil samples for laboratory analyses. Soil samples were analyzed for BTEX by USEPA Method SW-846/8020 and TPH-DRO by modified WDNR method. The locations of the soil borings are presented on Figure 5.13. The analytical results are presented in Appendix I.



SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995.

FIGURE 5.13

MINN\SITE-801

SITE PLAN
UST-SITE NO.3
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

OPTECH
OPERATIONAL TECHNOLOGIES CORPORATION

MAY 1996

One monitoring well was installed at UST – Site No. 3 for collection of groundwater samples for laboratory analyses. Monitoring well 801-001MW was installed in the soil overburden to an approximate depth of 11.5 feet BLS. The monitoring well is located in the inferred downgradient direction from the UST excavation (Liesch, 1992). The potentiometric surface of the unconfined groundwater measured in the monitoring well on 22 September 1995 was approximately 6.4 feet BLS (812.02 feet MSL). No hydrocarbon odor or sheen was noted in groundwater samples collected from the well. The monitoring well construction log is included in Appendix B. Information on well depth, screened interval, and water level is summarized in Table 5.2.

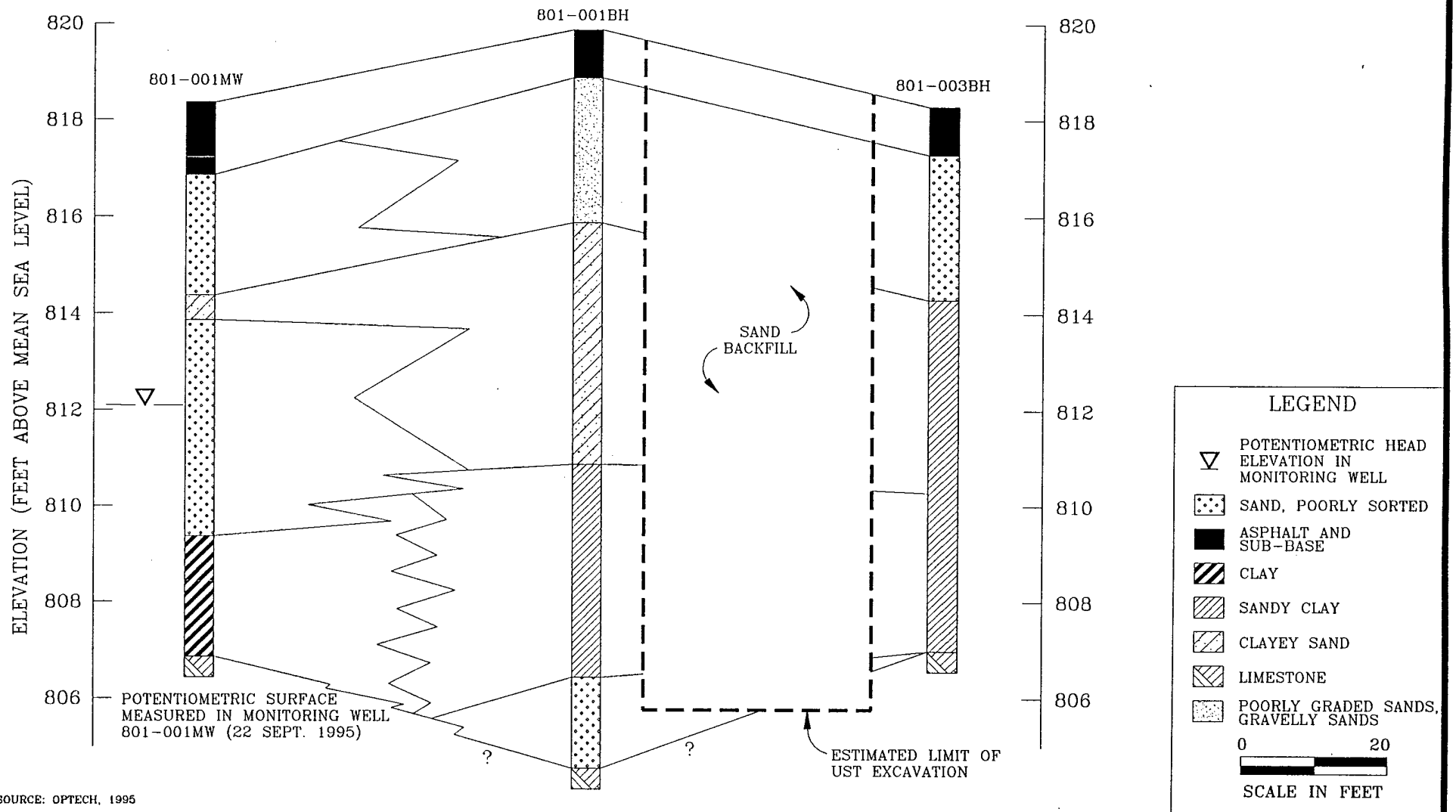
Two rounds of groundwater samples were conducted. The monitoring well was installed on 10 August 1995, and groundwater samples were collected on 16 August 1995 and 19 September 1995. The groundwater samples were analyzed for VOCs by USEPA Method SW-846/8240 and TPH-DRO by modified WDNR method. The analytical results are presented in Appendix I.

A fourth soil boring, 801-002ABH, was attempted but was abandoned at a depth of approximately 5.0 feet BLS when apparent pieces of plastic liner, similar to that described as lining the UST excavation, were encountered. No soil samples were analyzed from soil boring 801-002ABH.

5.3.1 Site Geology and Groundwater Conditions

Geologic information obtained from soil borings and the monitoring well borehole were used to describe the subsurface geology according to ASTM Method D-2488-90. Lithologic logs are presented in Appendix A, Boring Logs. The depth to groundwater encountered during drilling operations was recorded on the boring logs. The geologic cross-section depicting the subsurface geology at UST – Site No. 3 is indexed in Figure 5.13 and is presented as Figure 5.14.

The glacial deposits overlying the bedrock at UST – Site No. 3 consists of a heterogenous mixture of quartz sands, clayey sand and sandy clay. Approximately 2.0 to 3.5 feet of clay was encountered overlying bedrock. The depth to bedrock, as indicated by auger refusal, averages 13.0 feet BLS, the approximate depth of the UST excavation. The bedrock underlying the glacial deposits is the Ordovician Platteville Limestone and is composed of thin- to medium-bedded, gray and yellowish-brown dolomite and dolomitic limestone (Liesch, 1992).



SOURCE: OPTECH, 1995

FIGURE 5.14

GEOLOGIC CROSS-SECTION A-A'
UST-SITE NO.3
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

MINNEAPO\AA-801

OPTECH
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JANUARY 1996

Due to the apparent discontinuous nature of groundwater perched above the Platteville Formation (limestone), no definitive groundwater flow direction can be estimated based on water level measurements in monitoring wells installed in the shallow perched zone during the SI at the other UST sites (Figure 5.1). The inferred groundwater flow direction in the vicinity of the Minneapolis International Airport is generally to the north and northwest (Liesch, 1992).

On 20 September 1995, a rising head slug test was conducted in monitoring well 801-001MW according to procedures detailed in Section 4.6. The hydraulic conductivity value was computed from the Bouwer and Rice (1976) method for unconfined conditions using the AQTESOLV 2.0 Version computer program (Geraghty & Miller, Inc., 1994). The hydraulic conductivity was calculated to be 94 feet per day (ft/day).

5.3.2 Field Screening Results

Twelve subsurface soil samples and one groundwater sample were field screened for BTEX with a Photovac 10S+ Portable GC as described in Section 4.3. The field screening results are summarized in Table 5.9. Complete field GC data for all samples are presented in Appendix C.

Benzene was detected in soil samples collected from all soil borings and the monitoring well borehole at a maximum concentration of 3 ppb. Ethylbenzene was detected in one soil sample collected from soil boring 801-002BH at the 1.5- to 2.5-foot interval at a concentration of 3 ppb. Total xylenes was detected in soil samples collected from soil borings 801-002BH, 801-003BH, and 801-003BH, and the monitoring well borehole at a maximum concentration of 86 ppb. Toluene was not detected in any soil samples.

Benzene was detected at a concentration of 3 ppb in the groundwater sample collected from monitoring well 801-001MW. Toluene, ethylbenzene, and total xylenes were not detected in groundwater sampled from 801-001MW.

5.3.3 Soil Contamination

Analytical results for BTEX and TPH-DRO detected in soil samples collected at UST – Site No. 3 are presented in Table 5.10. The maximum concentrations of benzene, toluene, ethylbenzene, total xylenes, and TPH-DRO was detected in a soil sample collected from soil boring 801-001BH at the 9.0- to 10.0-foot interval at concentrations of 130 μg/kg, 140 μg/kg, 790 μg/kg, 5,200 μg/kg, and 2,100 μg/kg. The results of soil sample BTEX analyses are shown in Figure 5.15, and results for the TPH-DRO analyses are shown in Figures 5.16 and 5.17.

Table 5.9
Results of Soil and Groundwater Field Screening for UST – Site No. 3
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

Sample Location Number	Matrix	Sample Depth (ft. BLS)	Maximum ATHA Readings (ppm)	Field GC Screening			
				Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	Total Xylenes (ppb)
801-001BH	Soil	1.5 - 2.5	0	1	ND	ND	ND
801-001BH	Soil	4.0 - 5.0	0	1	ND	ND	ND
801-001BH	Soil	9.0 - 10.0	587	ND	ND	ND	ND
801-002BH	Soil	1.5 - 2.5	0	1	ND	3	57
801-002BH	Soil	4.0 - 5.0	0	1	ND	ND	ND
801-002BH	Soil	9.0 - 10.0	0	1	ND	ND	ND
801-003BH	Soil	1.5 - 2.5	0	1	ND	ND	41
801-003BH	Soil	4.0 - 5.0	0	1	ND	ND	41
801-003BH	Soil	9.0 - 10.0	11.3	1	ND	ND	29
801-001MW	Soil	2.0 - 3.0	0	1	ND	ND	26
801-001MW	Soil	4.0 - 5.0	0	1	ND	ND	24
801-001MW	Soil	9.0 - 10.0	0	3	ND	ND	86
801-001MW	Water	–	–	3	ND	ND	ND

ft. BLS – feet Below Land Surface.
BH – Borehole.
MW – Monitoring Well.
UST – Underground Storage Tank.
GC – Gas Chromatograph.
ppb – parts per billion.
ppm – parts per million.
PID – Photoionization Detector.
ATHA – Ambient Temperature Headspace Analysis.

Table 5.10
Results of BTEX and TPH-DRO Analyses for Soil Samples
Collected at UST – Site No. 3
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

Sample ID/Interval (ft. BLS)	Sample Date	TPH-DRO (mg/kg)	Benzene (µg/kg)	Toluene (µg/kg)	Ethylbenzene (µg/kg)	Total Xylenes (µg/kg)
801-001BH 9.0 - 10.0	9 Aug 95	2,100	130	140	790	5,200
801-001 DUP 9.0 - 10.0	9 Aug 95	2,100	1U	1U	1,700	10,000
801-001BH 13.5 - 13.8	9 Aug 95	10	2	1U	1	2
801-002BH 4.0 - 5.0	9 Aug 95	15	1U	1U	1U	1U
801-002BH 9.0 - 10.0	9 Aug 95	12	1U	1U	1U	1
801-001 Field Blank	9 Aug 95	0.1U	1U	1U	1U	1U
801-001 Equipment Blank	9 Aug 95	0.1U	1U	1U	1U	1U
Trip Blank	9 Aug 95	NA	1U	1U	1U	1U
801-003BH 4.0 - 5.0	10 Aug 95	8.3	1U	1U	1U	1U
801-003BH 9.0 - 10.0	10 Aug 95	9.3	1U	1U	1U	1U
Trip Blank	10 Aug 95	NA	1U	1U	1U	1U

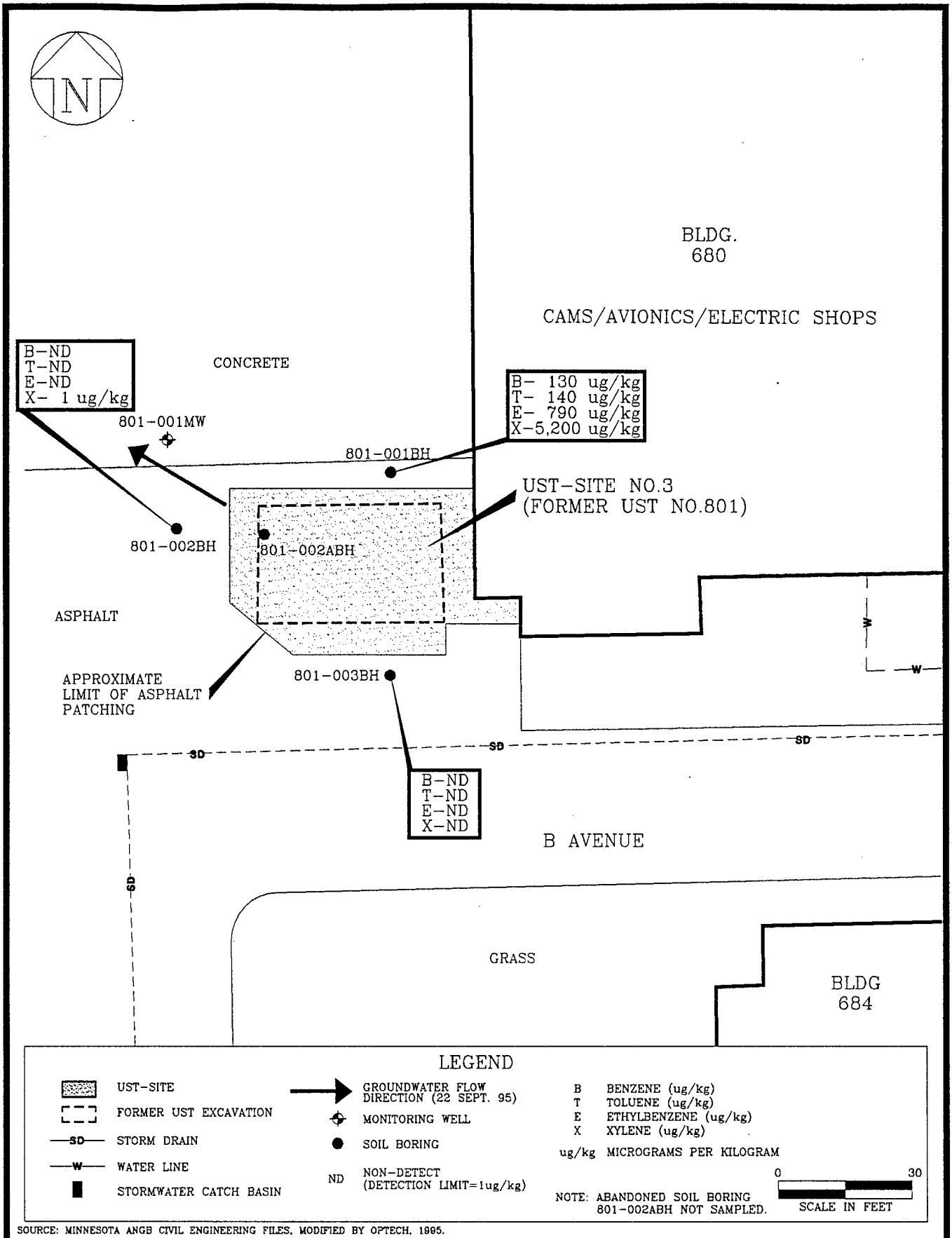
U – Compound was analyzed for but was not detected. Detection limit is shown.
BH – Borehole.
UST – Underground Storage Tank.
ft. BLS – feet Below Land Surface.
ID – Identification.
µg/kg – micrograms per kilogram.
mg/kg – milligrams per kilogram.
TPH-DRO – Total Petroleum Hydrocarbons-Diesel Range Organics.
DUP – Duplicate.
NA – Not Analyzed.
BTEX – Benzene, Toluene, Ethylbenzene, and Xylenes.

5.3.4 Groundwater Contamination

Analytical results for VOCs and TPH-DRO detected in groundwater samples collected from UST – Site No. 3 are presented in Table 5.11. No VOCs were detected in the groundwater samples collected at UST – Site No. 3. TPH-DRO was detected only in the groundwater sample taken during the 16 August 1995 sampling round at a concentration 0.19 mg/L (Figure 5.18).

5.3.5 Conclusions

During the previous investigation, conducted during Bay West, Inc.'s, UST removal activities in September 1993, BTEX constituents were detected in soil samples from the excavation floor (13.0 feet BLS) at concentrations ranging up to 14 mg/kg. Benzene was detected in one sample



SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995.

FIGURE 5.15

MINN\SITE-801

MAXIMUM BTEX DETECTED IN SOIL SAMPLES (9.0-10.0 ft BLS)
UST-SITE NO.3
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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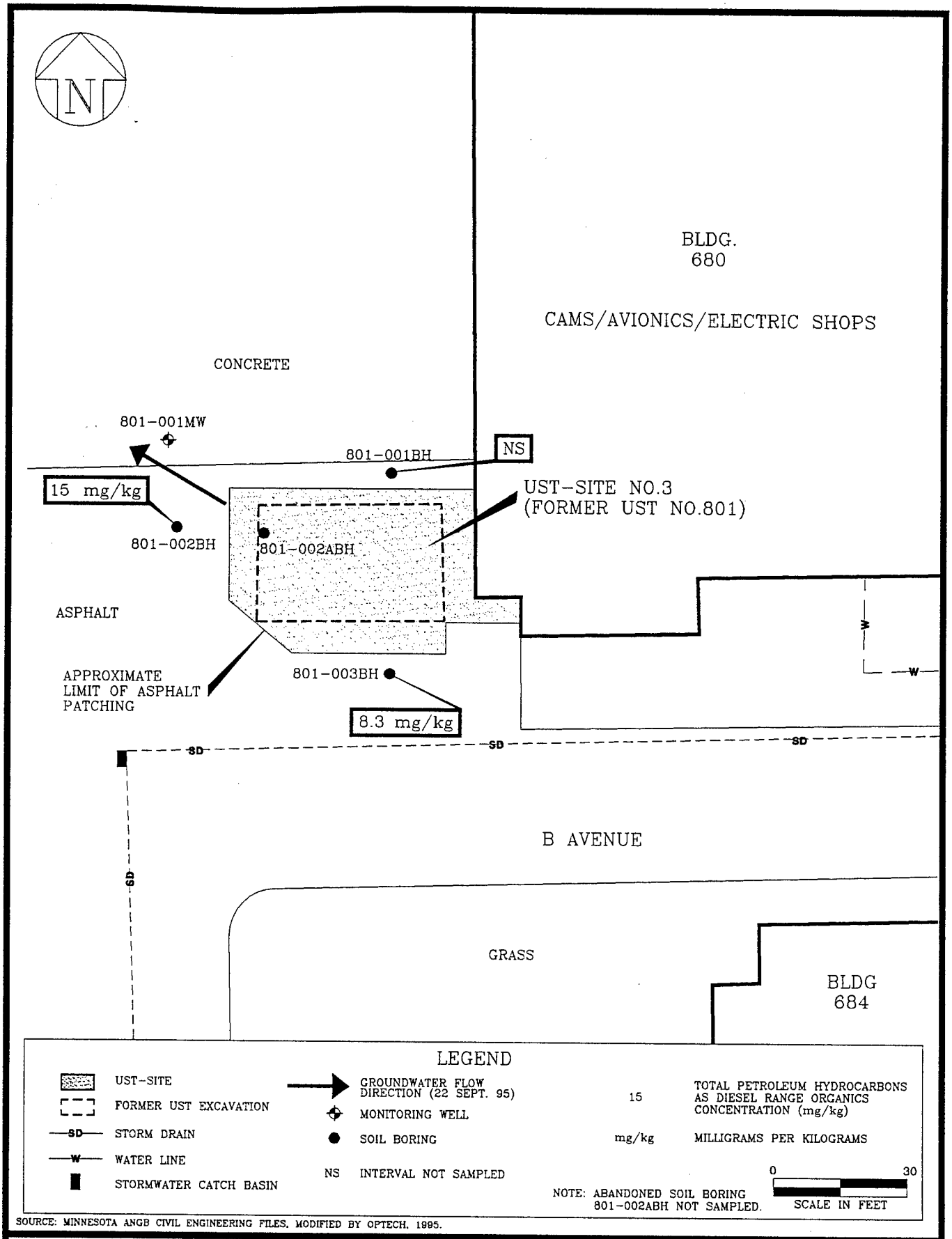

SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES. MODIFIED BY OPTECH, 1995.

FIGURE 5.16

MINN\SITE-801

TPH-DRO DETECTED IN SOIL SAMPLES (0.0-5.0 ft BLS) UST-SITE NO.3

133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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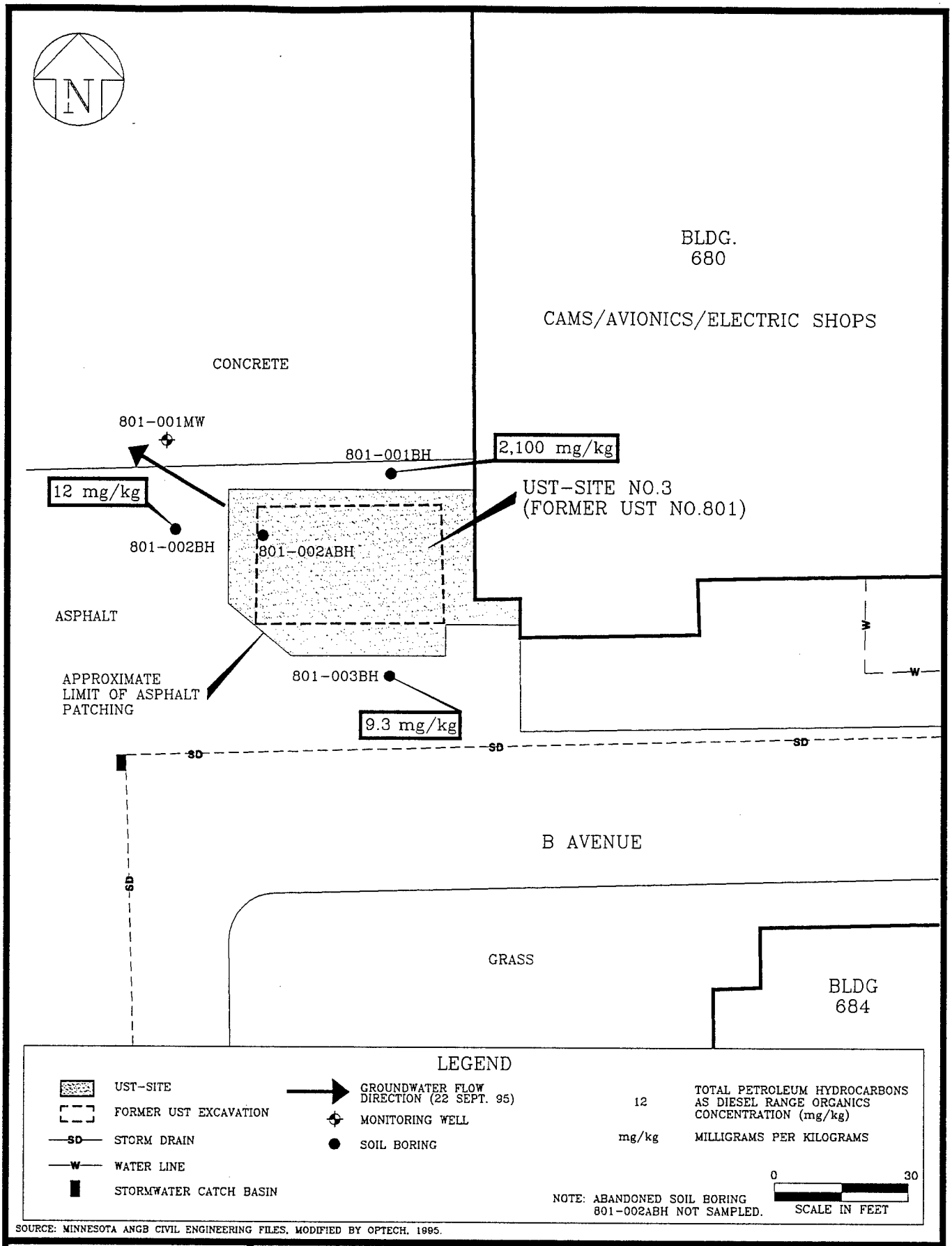

SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995.

FIGURE 5.17

MINN\SITE-801

TPH-DRO DETECTED IN SOIL SAMPLES
(9.0-10.0 ft BLS) UST-SITE NO.3

133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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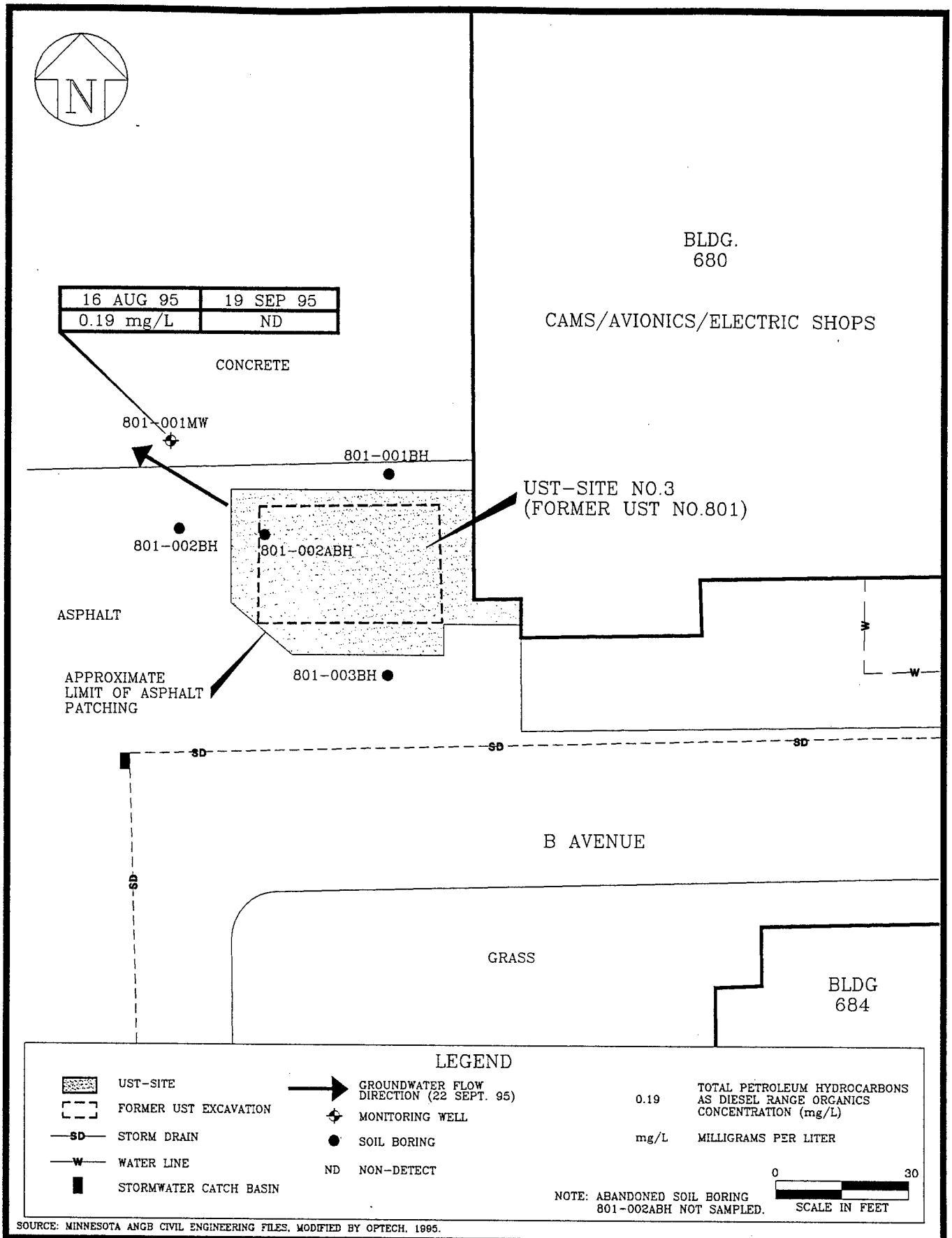
MAY 1996



SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995.

FIGURE 5.18

MINN\SITE-801

TPH-DRO DETECTED IN GROUNDWATER SAMPLES UST-SITE NO.3

133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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MAY 1996

Table 5.11
Results of VOC and TPH-DRO Analyses for Groundwater Samples
Collected at UST – Site No. 3
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

Sample ID	Sample Date	TPH-DRO (mg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethyl-benzene (µg/L)	Total Xylenes (µg/L)	Other SW8240 VOCs (µg/L)
801-001MW	16 Aug 95	0.19	5U	5U	5U	5U	5U
801-001MW	19 Sep 95	0.1U	5U	5U	5U	5U	5U
801-Field Blank	19 Sep 95	0.1U	5U	5U	5U	5U	5U
Trip Blank-2	19 Sep 95	N/A	5U	5U	5U	5U	5U
MCLs	–	N/A	5	1,000	700	10,000	N/A

U – Compound was analyzed for but was not detected. Detection limit is shown.
MW – Monitoring Well.
UST – Underground Storage Tank.
ID – Identification.
N/A – Not Applicable.
µg/L – micrograms per liter.
mg/L – milligrams per liter.
TPH-DRO – Total Petroleum Hydrocarbons-Diesel Range Organics.
DUP – Duplicate.
MCL – Maximum Contaminant Level.

only at a concentration of 0.23 mg/kg. TPH-DRO was detected in the excavation floor samples at concentrations ranging from 880 to 12,000 mg/kg.

During the August 1995 SI, one soil sample collected from a depth of 9.0 to 10.0 feet BLS in soil boring 801-001BH exhibited a total BTEX concentration of 6.26 mg/kg (the duplicate sample exhibited 11.7 mg/kg). Benzene was present in the sample at 0.130 mg/kg; xylene at 5.2 mg/kg. Total BTEX concentrations in the other soil samples collected at the site were less than 0.005 mg/kg. TPH-DRO was detected at a concentration of 2,100 mg/kg in the 9.0- to 10.0-foot BLS soil sample collected from soil boring 801-001BH. TPH-DRO detected in soil samples from all other sample intervals was relatively low, ranging from 8.3 to 15 mg/kg.

Based on the delineation results of the SI, the highest levels of soil contamination exists as residual concentrations of BTEX and TPH-DRO at a depth of approximately 10.0 feet BLS, just above bedrock and adjacent to the north edge of the UST excavation. The concentrations detected are consistent with residual contamination levels detected in excavation floor samples collected during the September 1993 UST removal activities. The northern extent of petroleum hydrocarbon contamination at levels of concern has not been delineated.

A water sample collected directly from the UST excavation during the Bay West, Inc., August 1993 removal activities exhibited a total BTEX concentration of 203 µg/L (13 µg/L

benzene) and a TPH-DRO concentration of 30 mg/L. The contamination detected in the water sample represents contact of groundwater with contaminated fill materials within the tank pit and cannot be considered representative of groundwater conditions at the site.

Analysis of the first round (16 August 1995) of groundwater samples collected from monitoring well 801-001MW, located in the inferred downgradient direction from the UST excavation, exhibited a maximum TPH-DRO concentration of 0.19 mg/L (detection limit of 0.1 mg/L). No TPH-DRO was detected in groundwater samples collected from the monitoring well during the second round (19 September 1995) of groundwater sampling. No VOCs were detected in any of the groundwater samples.

No significant groundwater contamination was identified during the SI.

5.3.6 Recommendations

Based on the results of the SI, no further investigative or remedial actions are warranted. Site closure should be requested from the MPCA. The recommendations are supported by the following:

- The contamination source has been removed, and residual contaminated soils are within a restricted area and are not exposed.
- Groundwater contamination at levels of concern has not been detected.
- There are no complete exposure pathways to sensitive receptors for soil or groundwater contamination. The nearest water wells listed are approximately 3,000 feet away and are not completed within the contaminated interval. Well records indicate that the wells produce groundwater from the Jordan Sandstone which is separated from shallower aquifers by a confining unit. Contaminated soils are not exposed and do not pose a significant vapor threat.

5.4 UST – SITE NO. 4 (FORMER USTs 651/652) – MPCA LEAK NO. 6580 INVESTIGATIVE FINDINGS

Seven soil borings were drilled at UST – Site No. 4 for collection of 19 soil samples for laboratory analyses. Soil samples were analyzed for BTEX and MTBE by USEPA Method SW-846/8020; TPH-DRO and TPH-GRO by modified WDNR method; and total lead

by USEPA Method SW-846/6010. The locations of the soil borings are presented on Figure 5.19. The analytical results are presented in Appendix I.

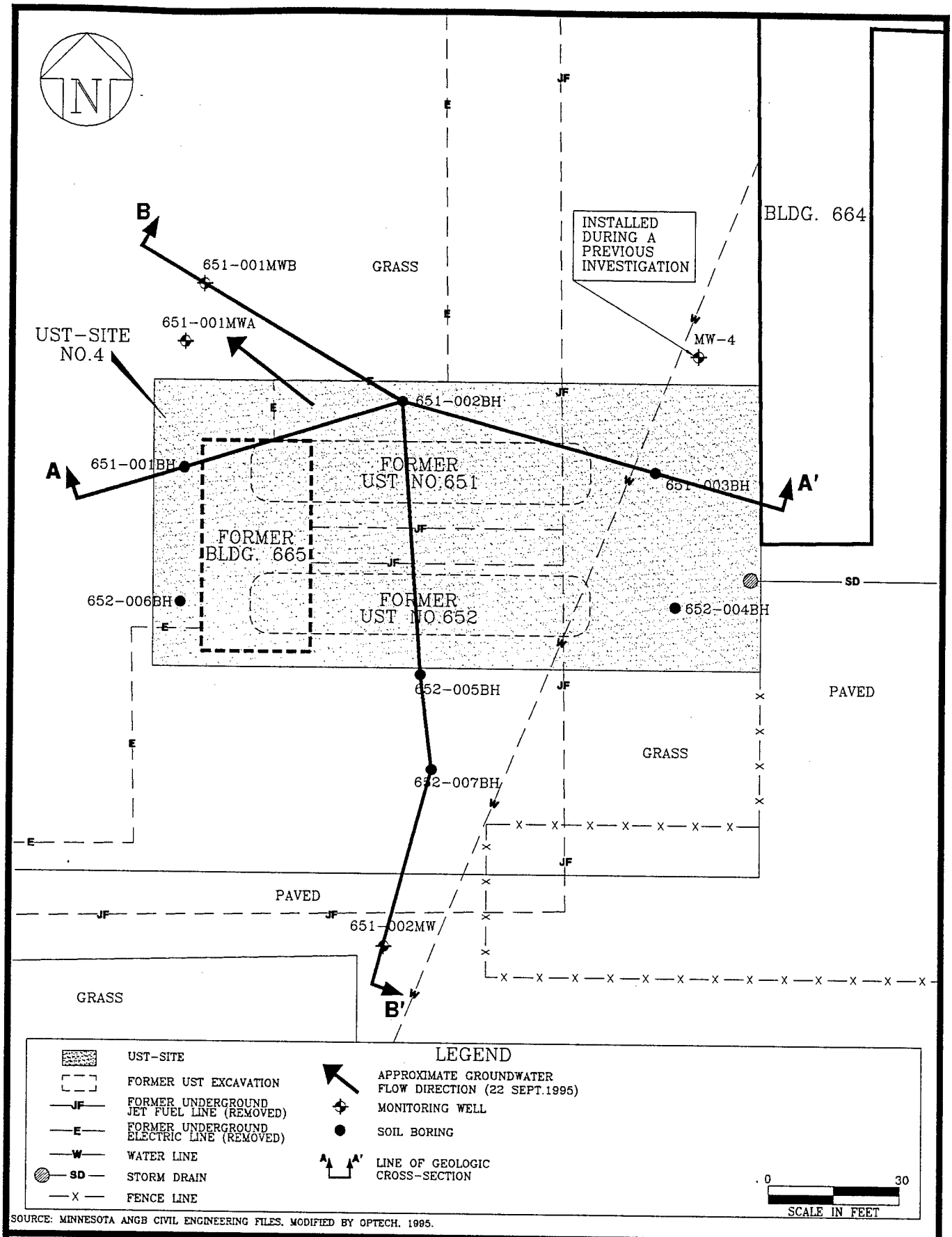
Three monitoring wells were installed at UST – Site No. 4 for collection of groundwater samples for laboratory analyses. Monitoring well 651-001MWA was completed within the soil overburden overlying bedrock (Platteville Formation) downgradient of the existing UST excavation. Monitoring wells 651-001MWB and 651-002MW were completed into the shallow confined aquifer present a few feet into the Platteville Formation. An existing monitoring well (MW-4), installed by Barr Engineering, Inc., in 1992 during an investigation at an adjacent site (see Section 2.1), was also utilized for obtaining groundwater samples at UST – Site No. 4. Monitoring well MW-4 is completed into the shallow Platteville confined aquifer at the same interval as SI monitoring wells 651-001MWB and 651-002MW. Monitoring well construction logs are included in Appendix B. Information on well depths, screened intervals, and water level measurements are summarized in Table 5.2.

Two rounds of groundwater sampling were conducted. Monitoring wells 651-001MWA, 651-002MW, and MW-4 were sampled on 17 August 1995 and 21 September 1995. Monitoring well 651-002MWB was sampled on 22 September 1995 and 26 October 1995. Standard groundwater sampling protocols followed during the SI are described in Subsection 4.4.3. Groundwater samples were analyzed for VOCs by USEPA Method SW8240; TPH-DRO and TPH-GRO by the modified WDNR Method; and for total lead by USEPA Method SW6010. The locations of the monitoring wells are presented on Figure 5.19. Analytical results for all analyses from this site are included in Appendix I.

Soil boring 652-005BH and monitoring well location 651-001MW were attempted but abandoned prior to attaining total depth when apparent pieces of plastic liner, similar to that described as lining the UST excavation, were encountered. Since the soil samples collected were judged to be representative of backfill emplaced in the excavation, no samples from these boreholes were submitted for laboratory analyses.

5.4.1 Site Geology and Groundwater Conditions

Geologic information obtained from soil borings and monitoring well boreholes were used to describe the subsurface geology according to ASTM Method D-2488-90. Lithologic logs are presented in Appendix A, Boring Logs. The depth to groundwater encountered during drilling operations were recorded on the boring logs. The geologic cross-sections depicting the



SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES. MODIFIED BY OPTECH. 1995.

FIGURE 5.19

MINN\SITE652

SITE PLAN
UST-SITE NO.4
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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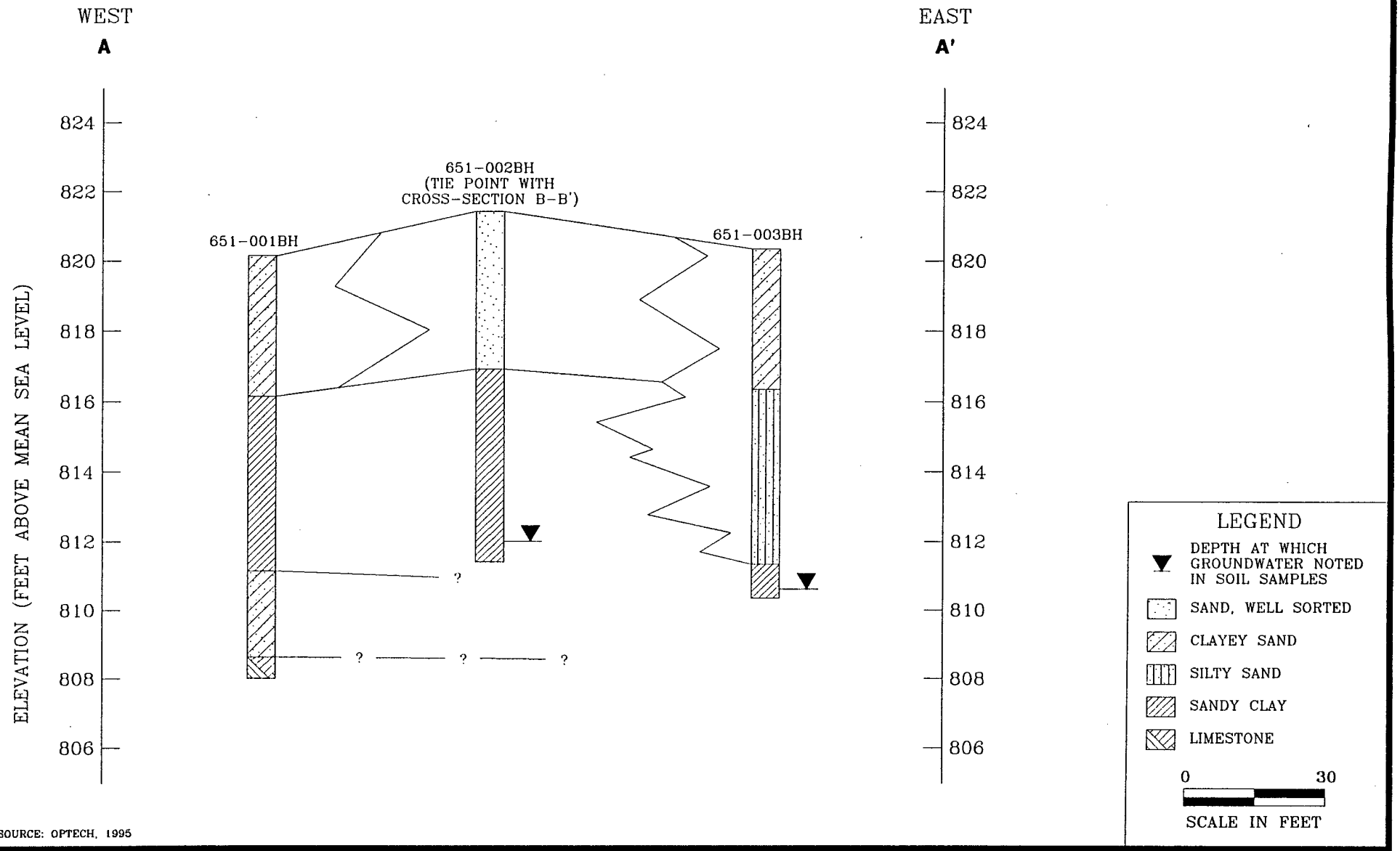
subsurface geology at UST – Site No. 4 are indexed in Figure 5.19 and are presented as Figures 5.20 and 5.21.

The glacial deposits overlying the bedrock at UST – Site No. 4 consists of a heterogeneous mixture of quartz sands, clayey sand and sandy clay overlying bedrock. The depth to bedrock, as indicated by auger refusal, averages 15.0 feet BLS across the site. The bedrock underlying the glacial deposits is the Ordovician Platteville Limestone and is composed of thin- to medium-bedded, gray and yellowish-brown dolomite and dolomitic limestone (Liesch, 1992).

Groundwater perched above bedrock was encountered in soil borings on the north and east sides of the UST excavation at an average depth of approximately 9.5 feet BLS. No groundwater was encountered in soil borings drilled in the soil overburden near the west and south sides of the excavation. This indicates that the perched groundwater body at the site is discontinuous. Therefore, groundwater gradient estimations based on water levels measured in monitoring wells completed in the shallow perched zone at the base may not be accurate.
The potentiometric surface of the confined Platteville aquifer interpreted from the water level data measured on 22 September 1995 is presented as Figure 5.22. The direction of groundwater movement at the site was to the west-northwest at a gradient of approximately 0.002 ft/ft (Figure 5.22). The inferred groundwater flow direction in the vicinity of the Minneapolis International Airport is generally to the north and northwest (Liesch, 1992). The estimated project area groundwater gradient is 0.003 ft/ft (Figure 5.3).

On 20 and 21 September 1995, a rising head slug test was conducted in monitoring wells 651-001MWA, 651-001MWB, 651-002MW, and MW-4 according to procedures detailed in Subsection 4.4.3. The hydraulic conductivity values were computed from the Bouwer and Rice (1976) method for unconfined conditions for slug test data obtained from monitoring well 651-001MWA and for confined conditions for slug test data obtained from monitoring wells 651-001MWB, 651-002MW, and MW-4 using the AQTESOLV 2.0 Version computer program (Geraghty & Miller, Inc., 1994). The hydraulic conductivities for monitoring wells 651-001MWA, 651-001MWB, 651-002MW, and MW-4 were calculated to be 77 ft/day, 16 ft/day, 135 ft/day, and 7 ft/day, respectively. The average hydraulic conductivity for the monitoring wells installed in the limestone bedrock is 53 ft/day (0.19 cm/s). The hydraulic conductivity values of the Platteville Limestone range from 1.2×10^{-3} to 6.6×10^{-4} cm/s (Liesch, 1992). The average linear groundwater velocity in the Platteville Limestone beneath the site is estimated at 192 ft/yr. The hydrologic unit effective porosity is estimated to be 20 percent (Freeze and Cherry, 1979).



SOURCE: OPTECH, 1995

FIGURE 5.20

GEOLOGIC CROSS-SECTION A-A'
UST-SITE NO.4
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

MINNEAPO\AA-651-2

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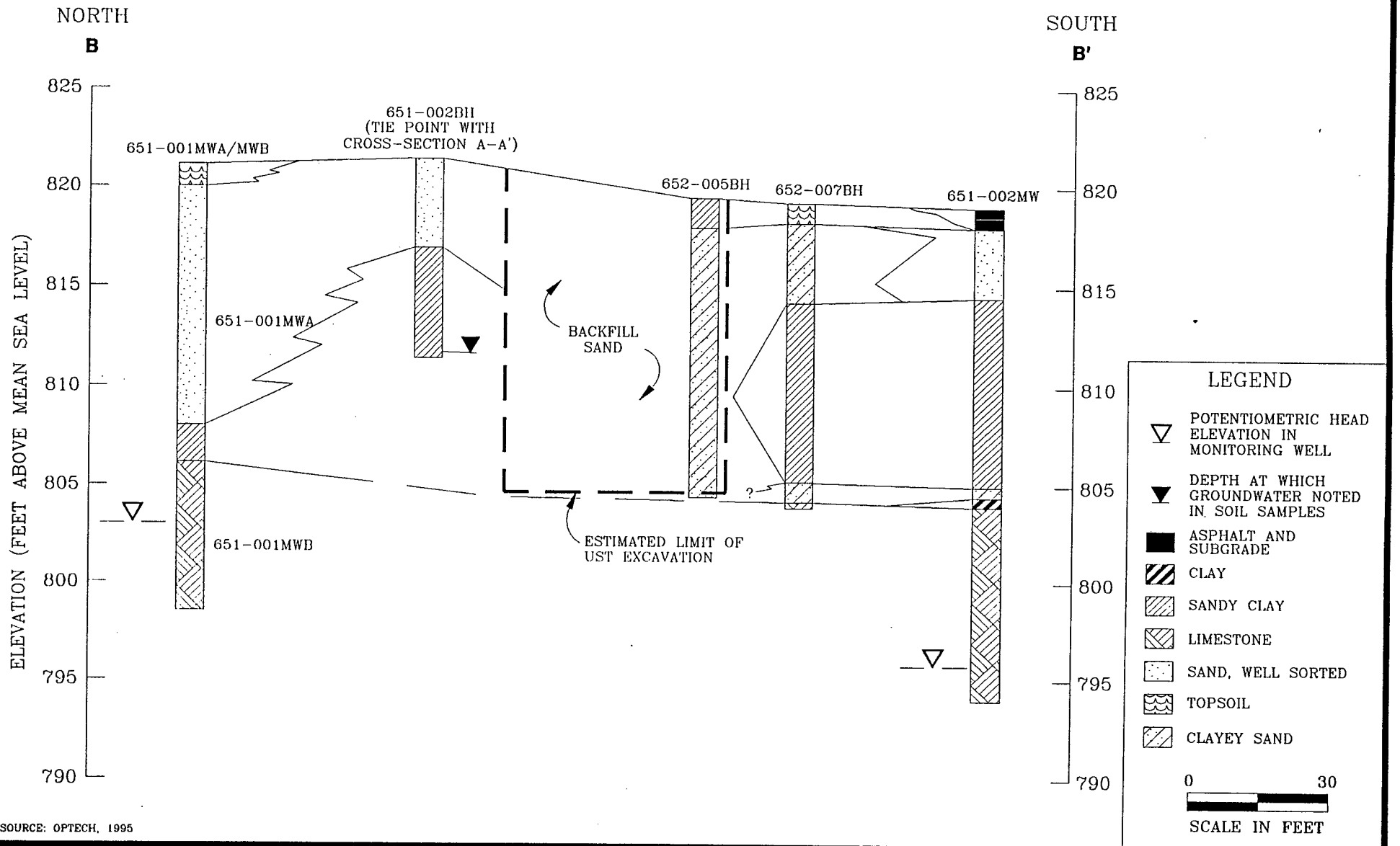

SOURCE: OPTECH, 1995

FIGURE 5.21

MINNEAPO\BB-651-2

GEOLOGIC CROSS-SECTION B-B'
UST-SITE NO.4

133rd AW, Minneapolis, ANGB
Minneapolis, Minnesota

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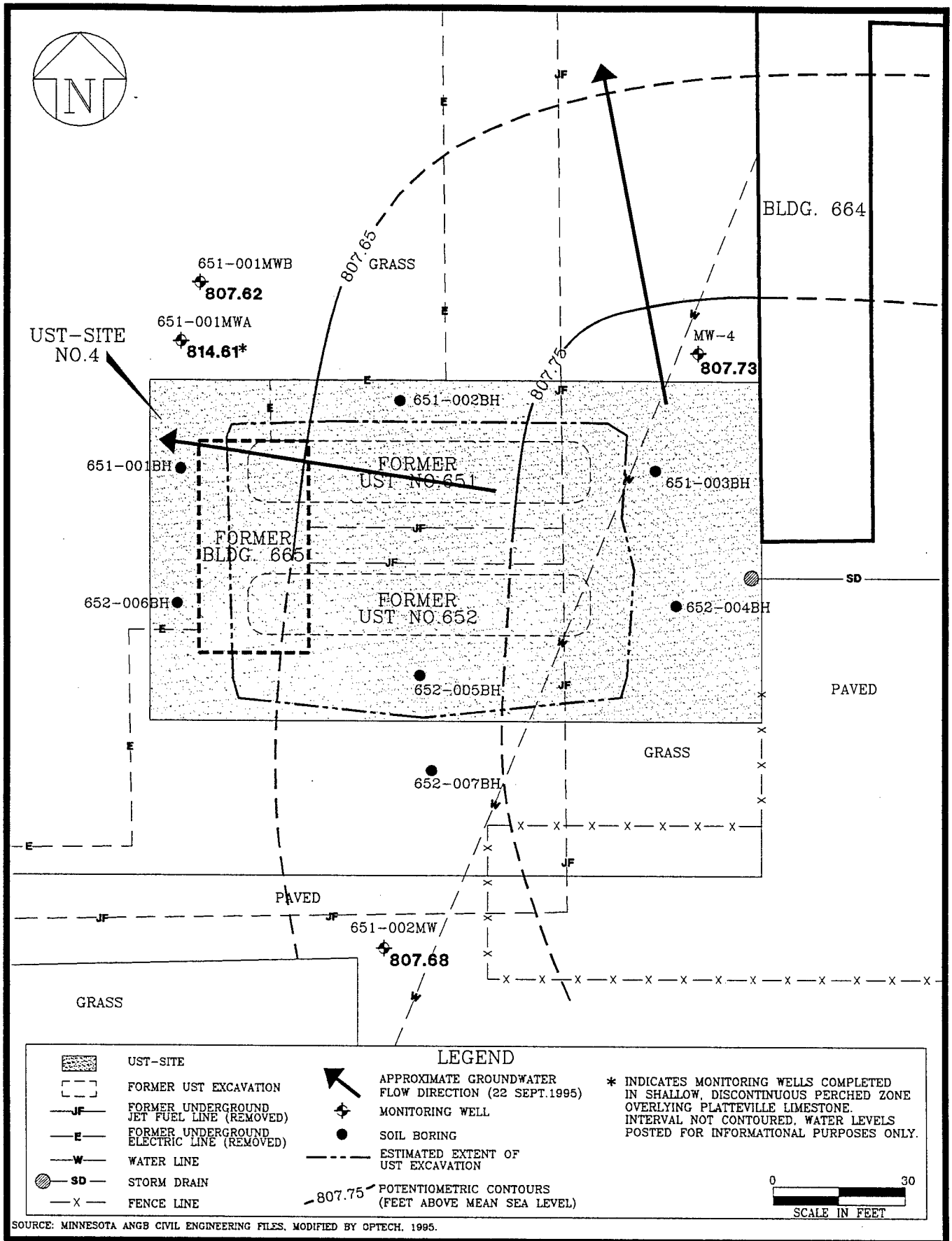

SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995.

FIGURE 5.22

MINN\SITE852

POTENTIOMETRIC MAP UST-SITE NO.4
CONFINED AQUIFER-PLATTEVILLE
AQUIFER 22 SEPTEMBER 1995
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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5.4.2 Soil and Groundwater Field Screening Results

Thirty-nine subsurface soil samples and three groundwater samples were field screened for BTEX with the Photovac 10S+ Portable GC as described in Section 4.3. The field screening results are presented in Table 5.12. Complete field GC data for soil and groundwater samples with QA/QC runs are presented in Appendix C.

Benzene was detected at a maximum concentration of 29 ppb from a soil sample collected from monitoring well borehole 651-002MW at the 22.0- to 24.0-foot interval. Toluene, ethylbenzene, and total xylenes were detected with maximum concentrations of 30,730 ppb, 1,120 ppb, and 8,510 ppb, respectively, from a soil sample collected from soil boring 652-007BH at the 3.5- to 5.0-foot interval.

Benzene, toluene, and total xylenes were detected at maximum concentrations of 6 ppb, 28 ppb, and 187 ppb, respectively, from a groundwater sample collected from monitoring well 651-002MW. Ethylbenzene was detected at a maximum concentration of 3 ppb from the groundwater sample collected from monitoring well 651-001MWA.

5.4.3 Soil Contamination

Analytical results for BTEX and MTBE concentrations detected in soil samples collected at UST – Site No. 4 are presented in Table 5.13. The results of BTEX analyses are shown in Figures 5.23 and 5.24. Benzene was detected in three soil samples, with the maximum concentration on 790 μg/kg in the soil sample collected from soil boring 652-007BH at the 1.0- to 2.0-foot interval. Ethylbenzene was detected in four soil samples, with the maximum concentration of 330 μg/kg detected in the soil sample collected from soil boring 652-007BH at the 1.0- to 2.0-foot interval. Total xylenes were detected in six soil samples, with the maximum concentration of 1,100 μg/kg detected in the soil sample collected from soil boring 652-007BH at the 1.0- to 2.0-foot interval. Toluene was not detected in any soil samples. MTBE, detected at a concentration of 72 μg/kg in one soil sample only, was collected from soil boring 651-003BH at the 8.5- to 10.0-foot interval.

Analytical results for TPH-DRO/GRO and lead concentrations detected in soil samples are presented in Table 5.14. TPH-DRO/GRO results are presented on Figures 5.25 and 5.26, and lead results are presented on Figure 5.27. TPH-DRO was detected in six soil samples, with the maximum concentration of 320 mg/kg detected in the soil sample collected from soil boring 651-003BH at the 0.0- to 2.0-foot interval. TPH-GRO was detected in three soil samples, with

Table 5.12
Results of Soil and Groundwater Field Screening for UST – Site No. 4
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

Sample Location Number	Matrix	Sample Depth (ft. BLS)	Maximum ATHA Readings (ppm)	Field GC Screening			
				Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	Total Xylenes (ppb)
651-001BH	Soil	0.5 - 2.0	20	ND	4	3	ND
651-001BH	Soil	3.5 - 5.0	0	ND	1	1	ND
651-001BH	Soil	8.5 - 10.0	0	ND	1	ND	ND
651-002BH	Soil	0.0 - 1.5	0	1	1	5	42
651-002BH	Soil	3.5 - 5.0	0	1	1	2	14
651-002BH	Soil	8.5 - 10.0	0	ND	1	ND	ND
651-003BH	Soil	0.0 - 2.0	1.9	ND	ND	ND	ND
651-003BH	Soil	3.5 - 5.0	1.9	ND	1	ND	ND
651-003BH	Soil	8.5 - 10.0	16.2	6	8	3	ND
652-004BH	Soil	0.0 - 1.5	258	ND	ND	ND	3
652-004BH	Soil	3.5 - 5.0	0	ND	ND	ND	ND
652-004BH	Soil	8.5 - 10.0	0	ND	1	ND	ND
652-005BH	Soil	0.0 - 1.5	0	1	1	ND	ND
652-005BH	Soil	3.5 - 5.5	144	ND	224	ND	ND
652-005BH	Soil	8.5 - 10.0	3	ND	435	4	ND
652-005BH	Soil	13.5 - 15.0	0	ND	57	ND	ND
652-006BH	Soil	0.0 - 1.5	0	1	1	ND	ND
652-006BH	Soil	3.5 - 5.0	0	2	ND	ND	ND
652-006BH	Soil	8.5 - 10.0	0	ND	ND	ND	ND
652-006BH	Soil	13.5 - 15.0	0	ND	ND	ND	ND
652-007BH	Soil	0.0 - 2.0	145	ND	1,942	295	21
652-007BH	Soil	2.0 - 3.5	115	ND	5,749	341	3,100
652-007BH	Soil	3.5 - 5.0	419	ND	30,730	1,120	8,510
652-007BH	Soil	8.0 - 10.0	0	ND	945	29	46
652-007BH	Soil	13.5 - 15.0	0	ND	97	16	19
651-001MW	Soil	0.0 - 1.5	0	ND	7	11	15
651-001MW	Soil	3.5 - 5.0	0	ND	11	5	8
651-001MW	Soil	8.5 - 10.0	0	ND	4	1	ND

Table 5.12 (Concluded)
Results of Soil and Groundwater Field Screening for UST – Site No. 4
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

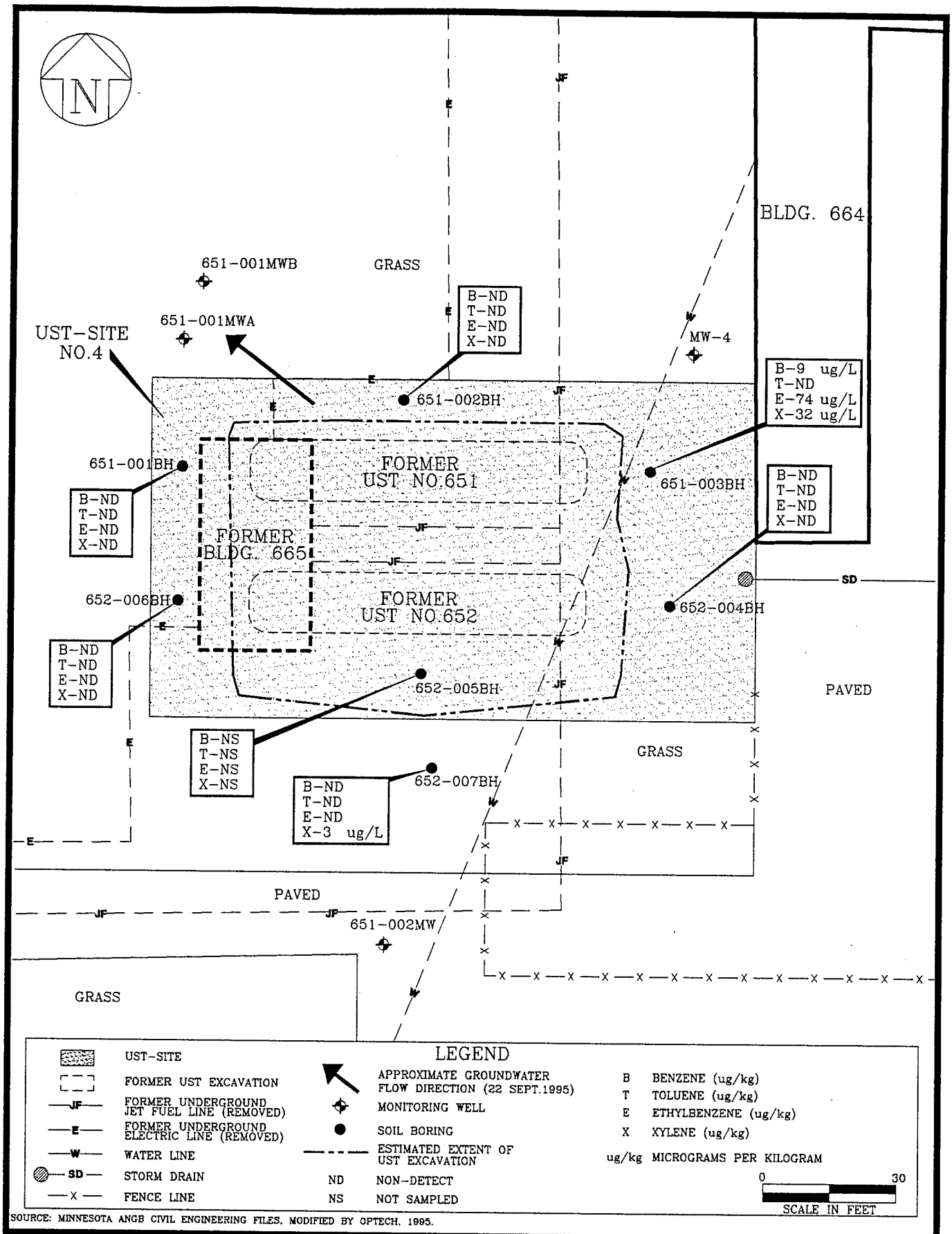
Sample Location Number	Matrix	Sample Depth (ft. BLS)	Maximum ATHA Readings (ppm)	Field GC Screening			
				Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	Total Xylenes (ppb)
651-001MWA	Soil	0.0 - 1.5	0	ND	3	ND	ND
651-001MWA	Soil	3.5 - 5.0	0	ND	2	ND	ND
651-001MWA	Soil	8.5 - 10.0	0	ND	2	ND	ND
651-001MWA	Soil	13.5 - 15.0	0	4	1	20	117
651-001MWA	Water	–	–	1	5	3	ND
651-002MW	Soil	1.5 - 3.5	1.9	ND	2	26	137
651-002MW	Soil	3.5 - 5.0	79	ND	3	85	95
651-002MW	Soil	8.5 - 10.0	0	ND	1	10	50
651-002MW	Soil	13.5 - 15.0	0	6	1	5	12
651-002MW	Soil	15.0 - 15.5	1.5	2	9	2	19
651-002MW	Soil	17.0 - 20.0	0.5	ND	5	ND	12
651-002MW	Soil	20.0 - 22.0	0	1	ND	ND	14
651-002MW	Soil	22.0 - 24.0	5.5	29	126	35	228
651-002MW	Water	–	–	6	28	2	187
651-001MWB	Soil	15.2 - 17.0	0	NA	NA	NA	NA
651-001MWB	Soil	18.0 - 20.0	0	NA	NA	NA	NA
651-001MWB	Soil	20.0 - 22.0	0	NA	NA	NA	NA

ft. BLS – feet Below Land Surface.
BH – Borehole.
DUP – Duplicate.
UST – Underground Storage Tank.
ppb – parts per billion.
ppm – parts per million.
PID – Photoionization Detector.

Table 5.13
Results of BTEX and MTBE Analyses for Soil Samples Collected at UST – Site No. 4
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

Sample ID/Interval (ft. BLS)	Sample Date	Benzene (µg/kg)	Toluene (µg/kg)	Ethylbenzene (µg/kg)	Total Xylenes (µg/kg)	MTBE (µg/kg)
651-001BH 0.0 - 1.5	1 Aug 95	1U	1U	1U	1U	1U
651-001BH 8.5 - 10.0	1 Aug 95	1U	1U	1U	1U	1U
651-002BH 0.0 - 1.5	1 Aug 95	1U	1U	39	180	1U
651-002BH 8.5 - 10.0	1 Aug 95	1U	1U	1U	1U	1U
Trip Blank	1 Aug 95	1U*	1U*	1U*	1U*	1U*
651-003BH 0.0 - 2.0	2 Aug 95	1U	1U	1U	1U	1U
651-003BH-DUP 0.0 - 2.0	2 Aug 95	1U	1U	1U	1U	1U
651-003BH 3.5 - 5.0	2 Aug 95	1U	1U	1U	1U	1U
651-003BH 8.5 - 10.0	2 Aug 95	9	1U	74	32	72
652-004BH 0.0 - 1.5	2 Aug 95	1U	1U	1U	1U	1U
652-004BH 8.5 - 10.0	2 Aug 95	1U	1U	1U	1U	1U
652-006BH 0.0 - 1.5	2 Aug 95	1U	1U	1U	1U	1U
652-006BH 3.5 - 5.0	2 Aug 95	1U	1U	1U	1U	1U
652-006BH 13.5 - 15.0	2 Aug 95	1U	1U	1U	1U	1U
651-001 EB	2 Aug 95	1U*	1U*	1U*	1U*	1*
651-001 FB	2 Aug 95	1U*	1U*	1U*	1U*	2*
Trip Blank	2 Aug 95	1U*	1U*	1U*	1U*	1U*
652-007BH 1.0 - 2.0	3 Aug 95	790	1U	330	1,100	1U
652-007BH 2.5 - 3.5	3 Aug 95	36	1U	7	38	1U
652-007BH 9.0 - 10.0	3 Aug 95	1U	1U	1U	1	1U
652-007BH 14.0 - 15.0	3 Aug 95	1U	1U	1U	3	1U
651-002 EB	3 Aug 95	1U*	1U*	1U*	1U*	1U*
651-002 FB	3 Aug 95	1U*	1U*	1U*	1U*	1U*
Trip Blank	3 Aug 95	1U*	1U*	1U*	1U*	1U*

U – Compound was analyzed for but was not detected. Detection limit is shown.
BH – Borehole.
UST – Underground Storage Tank.
ft. BLS – feet Below Land Surface.
ID – Identification.
µg/kg – micrograms per kilogram.
* – micrograms per liter.
MTBE – Methyl tertiary-butyl ether.
DUP – Duplicate.
EB – Aqueous Equipment Blank.
FB – Aqueous Field Blank.
BTEX – Benzene, Toluene, Ethylbenzene, and Xylenes.



SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995.

FIGURE 5.23

MINN\SITE652

BTEX DETECTED IN SOIL (BELOW 5.0 ft. BLS) UST-SITE NO.4

133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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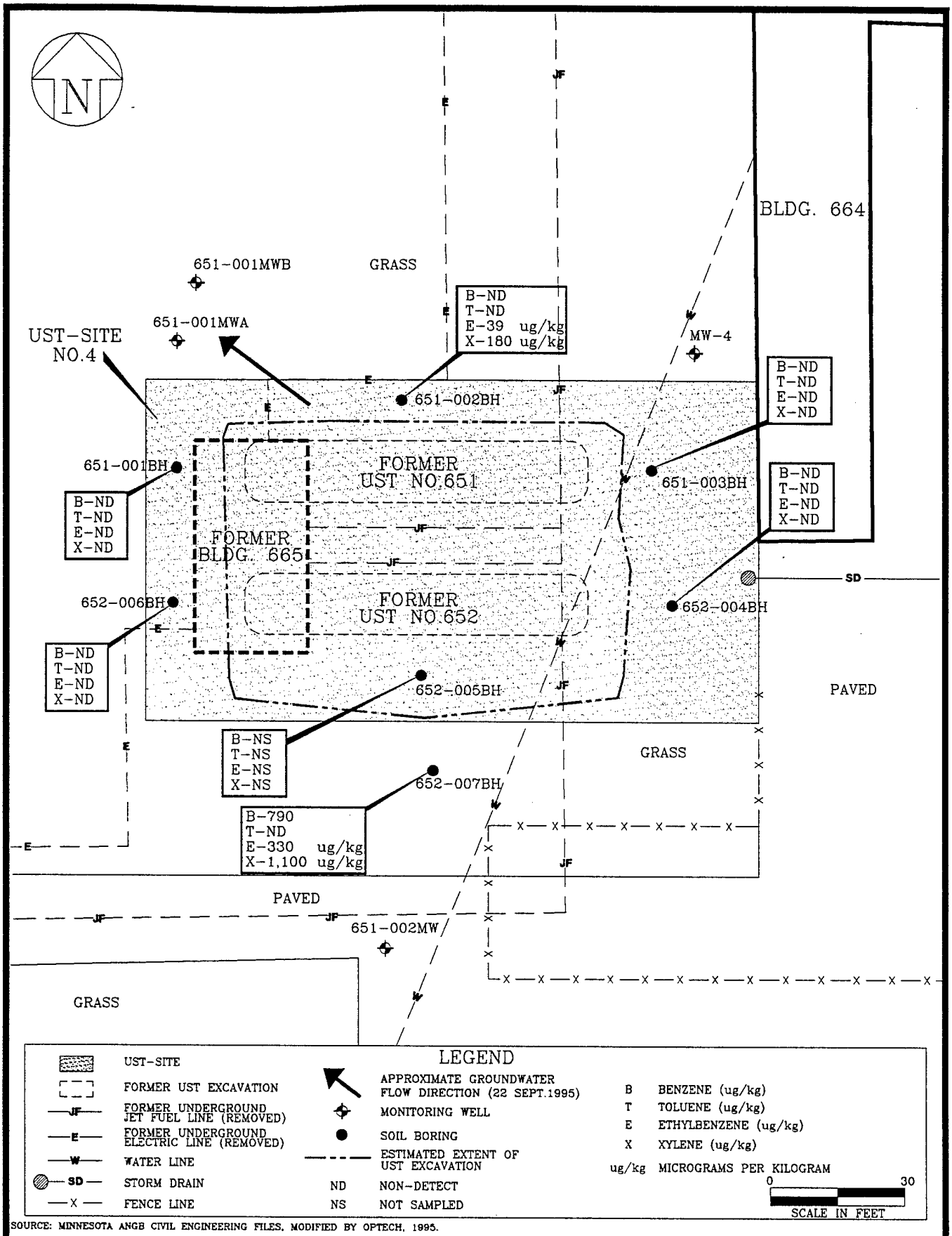

SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995.

FIGURE 5.24

MINN\SITE652

BTEX DETECTED IN SOIL
(0.0-5.0 ft. BLS) UST-SITE NO.4
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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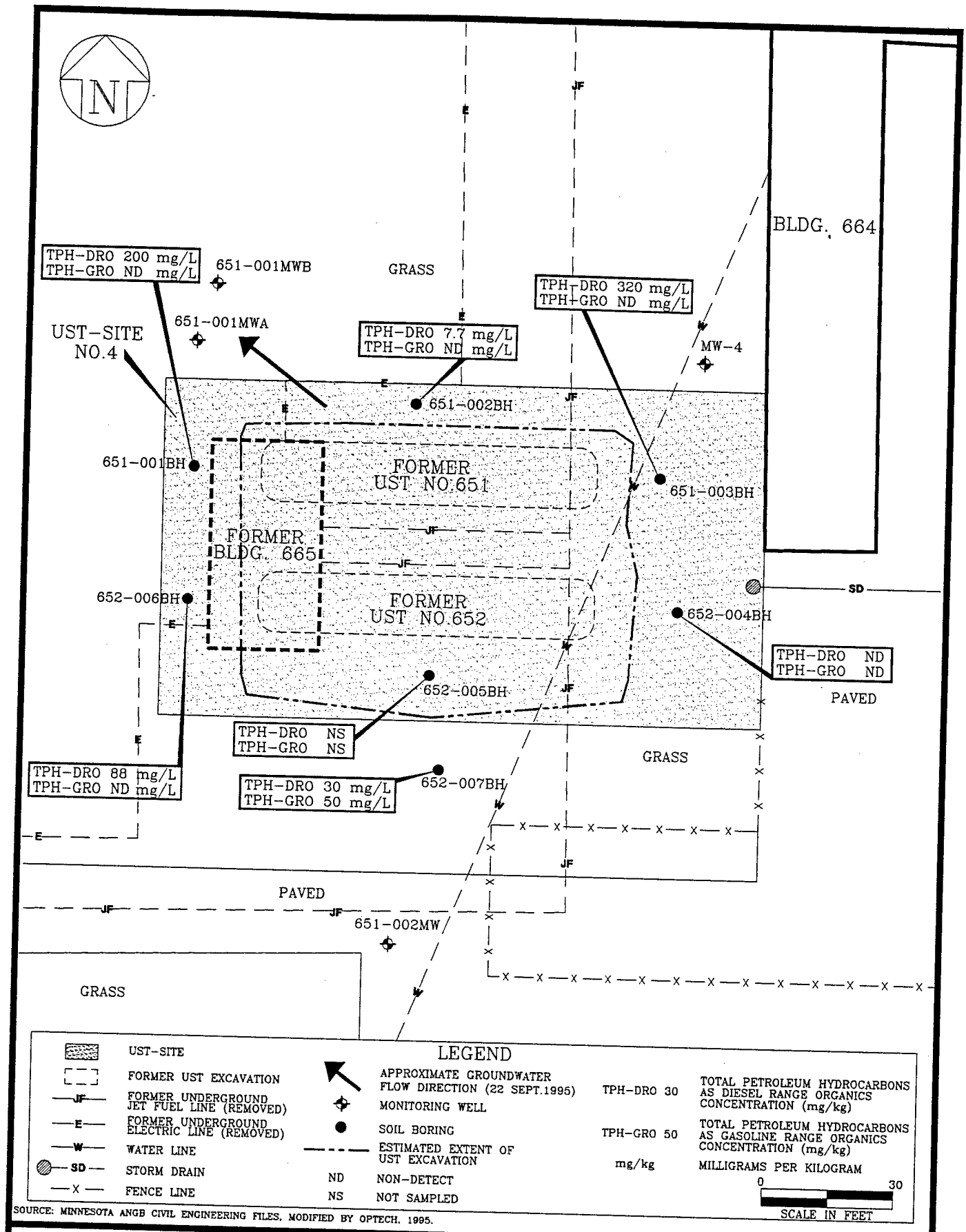

SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995.

FIGURE 5.25

MINN\SITE652

TPH-DRO AND TPH-GRO DETECTED IN SOIL (0.0-5.0 ft BLS) UST-SITE NO.4 133rd AW, Minnesota ANGB Minneapolis, Minnesota

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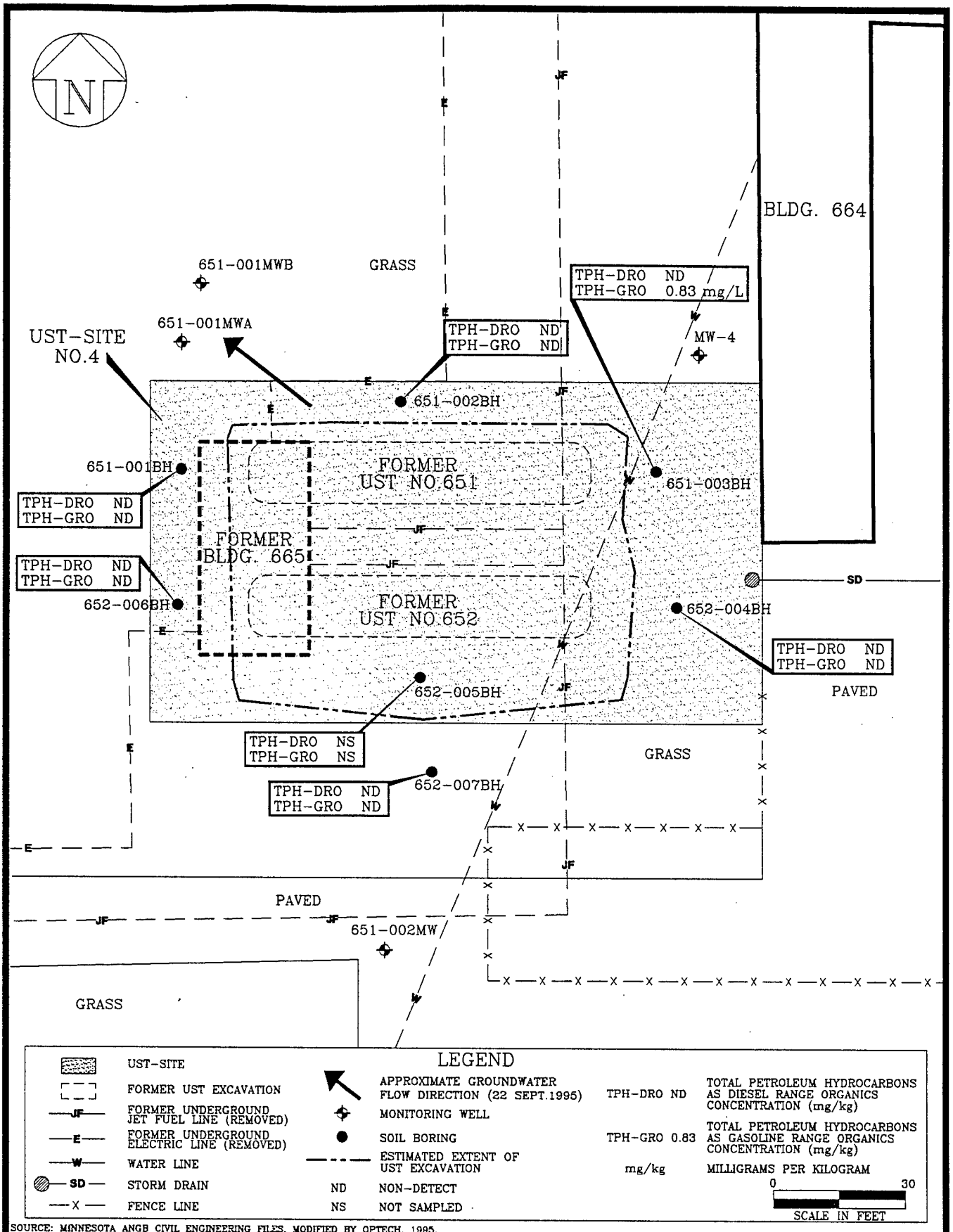

SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES. MODIFIED BY OPTECH, 1995.

FIGURE 5.26

MINN\SITE652

TPH-DRO AND TPH-GRO DETECTED IN SOIL (8.0-10.0 ft BLS)
UST-SITE NO.4
133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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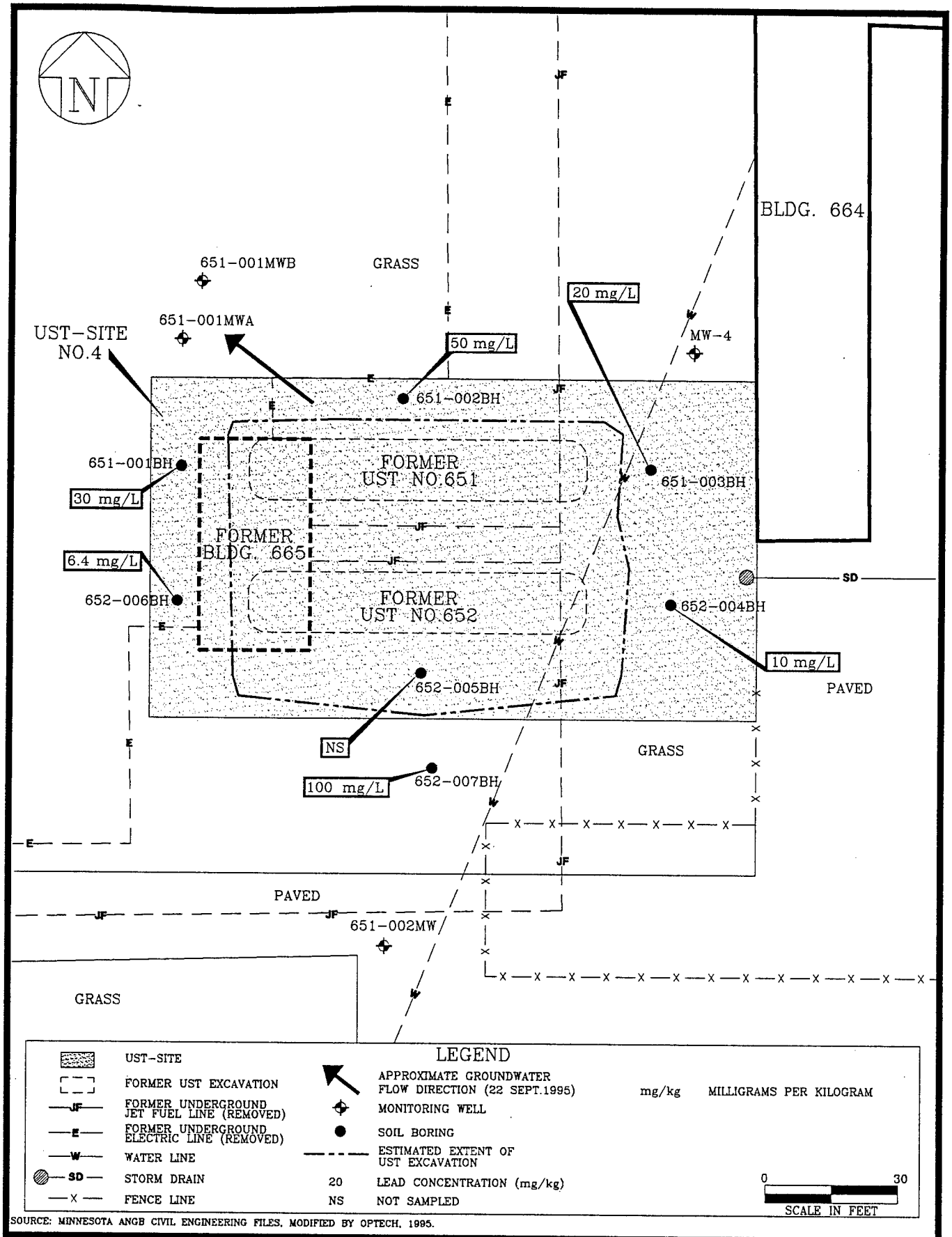

SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995.

FIGURE 5.27

MINN\SITE652

LEAD DETECTED IN SOIL (0.0-5.0 ft BLS) UST-SITE NO.4

133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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Table 5.14
Results of TPH-DRO/GRO and Lead Analysis for Soil Samples Collected at UST – Site No. 4
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

Sample ID/Interval (ft. BLS)	Sample Date	TPH-DRO (mg/kg)	TPH-GRO (mg/kg)	Lead (mg/kg)
651-001BH 0.0 - 1.5	1 Aug 95	200	0.1U	30
651-001BH 8.5 - 10.0	1 Aug 95	0.1U	0.1U	1U
651-002BH 0.0 - 1.5	1 Aug 95	7.7	0.1U	50
651-002BH 8.5 - 10.0	1 Aug 95	4U	0.1U	10
651-003BH 0.0 - 2.0	2 Aug 95	320	0.1U	20
651-003BH-DUP 0.0 - 2.0	2 Aug 95	4U	0.1U	30
651-003BH 3.5 - 5.0	2 Aug 95	4U	0.1U	10U
651-003BH 8.5 - 10.0	2 Aug 95	4U	0.83	10
652-004BH 0.0 - 1.5	2 Aug 95	4U	0.1U	10
652-004BH 8.5 - 10.0	2 Aug 95	4U	0.1U	10U
652-006BH 0.0 - 1.5	2 Aug 95	88	0.1U	6.4
652-006BH 3.5 - 5.0	2 Aug 95	4U	0.1U	10U
652-006BH 13.5 - 15.0	2 Aug 95	4U	0.1U	10U
651-001 EB	2 Aug 95	0.1U*	0.1U*	0.05U*
651-001 FB	2 Aug 95	0.1U*	0.1U*	0.05U*
652-007BH 1.0 - 2.0	3 Aug 95	22	50	100
652-007BH 2.5 - 3.5	3 Aug 95	30	2.8	3.3
652-007BH 9.0 - 10.0	3 Aug 95	4U	0.1U	8
652-007BH 14.0 - 15.0	3 Aug 95	4U	0.1U	3.9
651-002 EB	3 Aug 95	0.1U*	0.1U*	0.05U*
651-002 FB	3 Aug 95	0.1U*	0.1U*	0.05U*

U – Compound was analyzed for but was not detected. Detection limit is shown.
BH – Borehole.
UST – Underground Storage Tank.
ft. BLS – feet Below Land Surface.
ID – Identification.
mg/kg – milligrams per kilogram.
* – milligrams per liter.
DUP – Duplicate.
EB – Aqueous Equipment Blank.
FB – Aqueous Field Blank.
TPH-DRO – Total Petroleum Hydrocarbons-Diesel Range Organics.
TPH-GRO – Total Petroleum Hydrocarbons-Gasoline Range Organics.

the maximum concentration of 50 mg/kg detected in the soil sample collected from soil boring 652-007BH at the 1.0- to 2.0-foot interval. Lead was detected in 12 soil samples, with the maximum concentration of 100 mg/kg detected in the soil sample collected from soil boring 652-007BH at the 1.0- to 2.0-foot interval. Naturally occurring background concentrations of lead in soils in the Eastern United States ranges from <10 to 300 mg/kg (Shacklette and Boerngen, 1984).

5.4.4 Groundwater Contamination

Analytical results for VOCs detected in groundwater samples collected at UST – Site No. 4 are summarized in Table 5.15. Benzene and total xylenes were detected in groundwater samples collected from monitoring wells 651-001MWB, 651-002MW, and MW-4 during both sampling events at concentrations ranging from 6 μg/L to 39 μg/L and 44 μg/L to 860 μg/L, respectively. Ethylbenzene was detected in groundwater samples collected from monitoring wells MW-4 and 651-001MWB during both sampling events at concentrations ranging from 96 μg/L to 180 μg/L. Toluene was not detected in any groundwater samples submitted for laboratory analyses.

Benzene was detected in groundwater samples collected from monitoring well MW-4 at concentrations of 39 μg/L and 35 μg/L during the first and second sampling events, respectively, and from monitoring well 651-001MWB at a concentration of 14 μg/L during the first sampling event. These concentrations exceeded the MDH HRLs for drinking water of 10 μg/L. The distribution of VOCs detected in groundwater samples is shown on Figure 5.28.

Analytical results for TPH-DRO/GRO and lead detected in groundwater samples collected at UST – Site No. 4 are summarized in Table 5.16. TPH-DRO was detected in groundwater samples from all monitoring wells during both sampling events, except from monitoring well 651-001MWA during the second sampling event, at concentrations ranging from 0.55 mg/L to 3.92 mg/L. TPH-GRO was detected in groundwater samples from monitoring wells 651-001MWB, 651-002MW, and MW-4 during both sampling events at concentrations ranging from 0.21 mg/L to 29 mg/L. The maximum TPH-DRO/GRO concentrations were detected in the groundwater sample collected from monitoring well 651-001MWB. No lead was detected in the groundwater samples collected at UST – Site No. 4. The distribution of TPH-DRO/GRO detected in groundwater samples is shown on Figure 5.29.

5.4.5 Conclusions

During the previous investigation, conducted during Bay West, Inc.'s, UST removal activities in September 1993, BTEX constituents were detected in soil samples from the excavation floor and sidewalls at concentrations ranging from non-detect to 8.5 mg/kg; no benzene was detected. TPH–DRO was detected in all soil samples at concentrations ranging from 150 mg/kg to 840 mg/kg.

During the August 1995 SI, the highest BTEX concentrations were detected in near-surface soil samples from soil borings 651-007BH at the 1.0- to 2.0-foot interval and 651-002BH 0- to

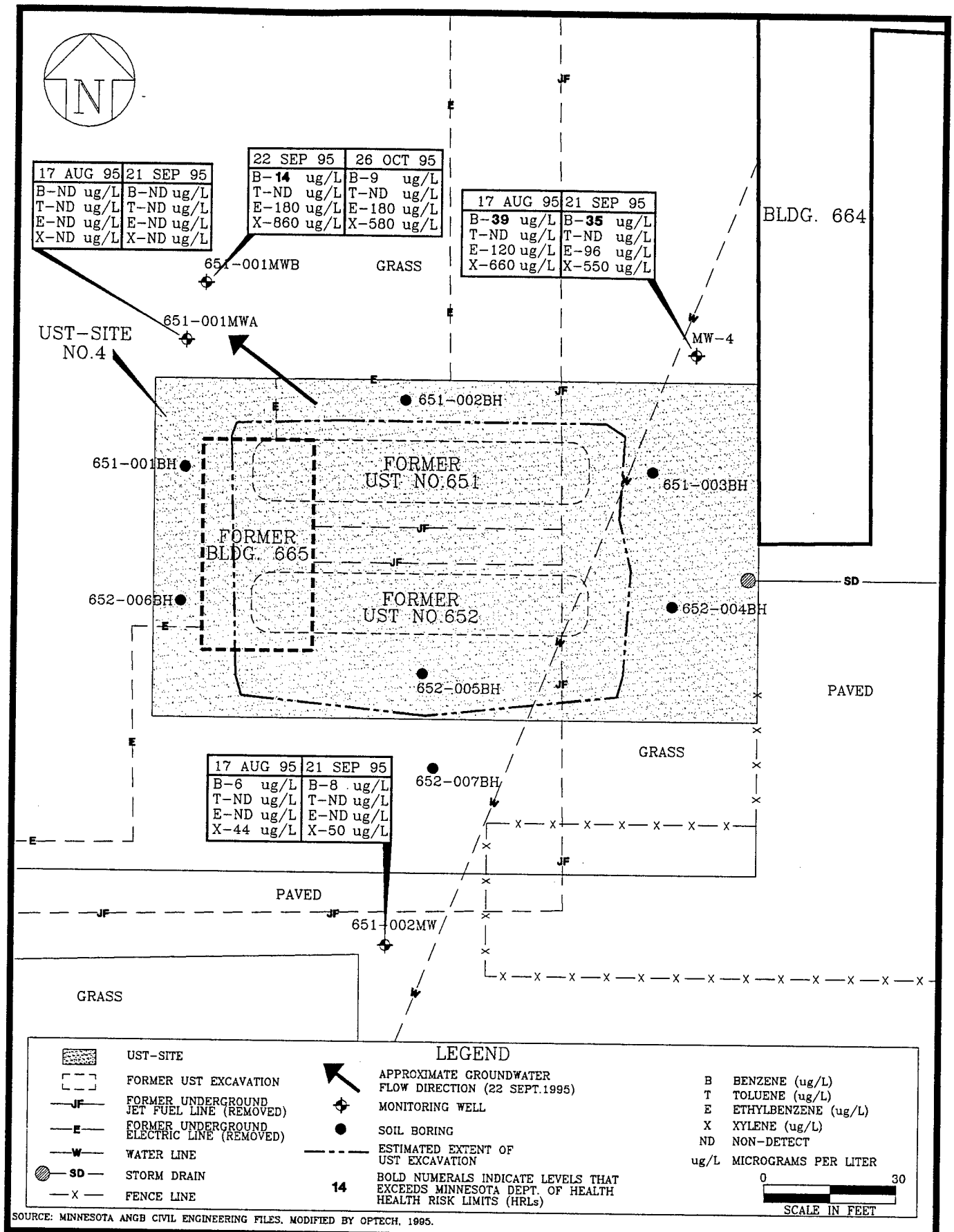
Table 5.15
Results of VOC Analysis of Groundwater Samples
Collected at UST – Site No. 4
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

Sample ID	Sample Date	Benzene (µg/L)	Toluene (µg/L)	Ethyl-benzene (µg/L)	Total Xylenes (µg/L)	Other Method SW8240 VOCs (µg/L)
651-001MWA	17 Aug 95	5U	5U	5U	5U	ND
651-001MWA DUP	17 Aug 95	5U	5U	5U	5U	ND
651-002MW	17 Aug 95	6	5U	5U	44	ND
MW-4	17 Aug 95	**39**	5U	120	660	ND
651-003 EB	17 Aug 95	5U	5U	5U	5U	ND
Trip Blank	17 Aug 95	5U	5U	5U	5U	ND
MW-4	21 Sep 95	**35**	5U	96	550	ND
MW-4 DUP	21 Sep 95	**35**	5U	100	570	ND
651-002MW	21 Sep 95	8	5U	5U	50	ND
651-001MWA	21 Sep 95	5U	5U	5U	5U	ND
Trip Blank	21 Sep 95	5U	5U	5U	5U	ND
651-001MWB	22 Sep 95	**14**	5U	180	860	ND
651-001MWB	26 Oct 95	9	5U	180	580	ND
Trip Blank	26 Oct 95	5U	5U	5U	5U	ND
MCLs	N/A	5	1,000	700	10,000	N/A

U – Compound was analyzed for but was not detected. Detection limit is shown.
MW – Monitoring Well.
UST – Underground Storage Tank.
ID – Identification.
µg/L – micrograms per liter.
MCL – Maximum Contaminant Level.
VOCs – Volatile Organic Compounds.
DUP – Duplicate.
ND – Non-detect at various detection limits.
14 – Bold numerals indicate a level that exceeds the Minnesota Department of Health, Health Risk Limits for Drinking Water limit of 10 µg/L.
N/A – Not Applicable.

1.5-foot interval at 2.2 mg/kg and 0.210 mg/kg, respectively. The maximum benzene concentration was detected at 0.790 mg/kg in the soil sample collected from soil boring 651-007BH at the 1.0- to 2.0-foot interval. Total BTEX concentrations in all soil samples collected from depths greater than 2.0 feet BLS ranged from 0.001 to 0.187 mg/kg (maximum benzene concentration of 0.036 mg/kg).

TPH-DRO concentrations detected in the SI soil samples collected from depth intervals less than 5.0 feet BLS ranged from non-detect to 320 mg/kg. The highest concentration of TPH-DRO was detected in the soil sample collected from soil boring 651-003BH at the 1.0- to 2.0-foot interval. At depth intervals greater than 5.0 feet BLS, TPH-DRO was not detected in the soil



SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES. MODIFIED BY OPTECH, 1995.

FIGURE 5.28

MINN\SITE852

BTEX DETECTED IN GROUNDWATER SAMPLE ROUNDS 1 AND 2 UST-SITE NO.4

133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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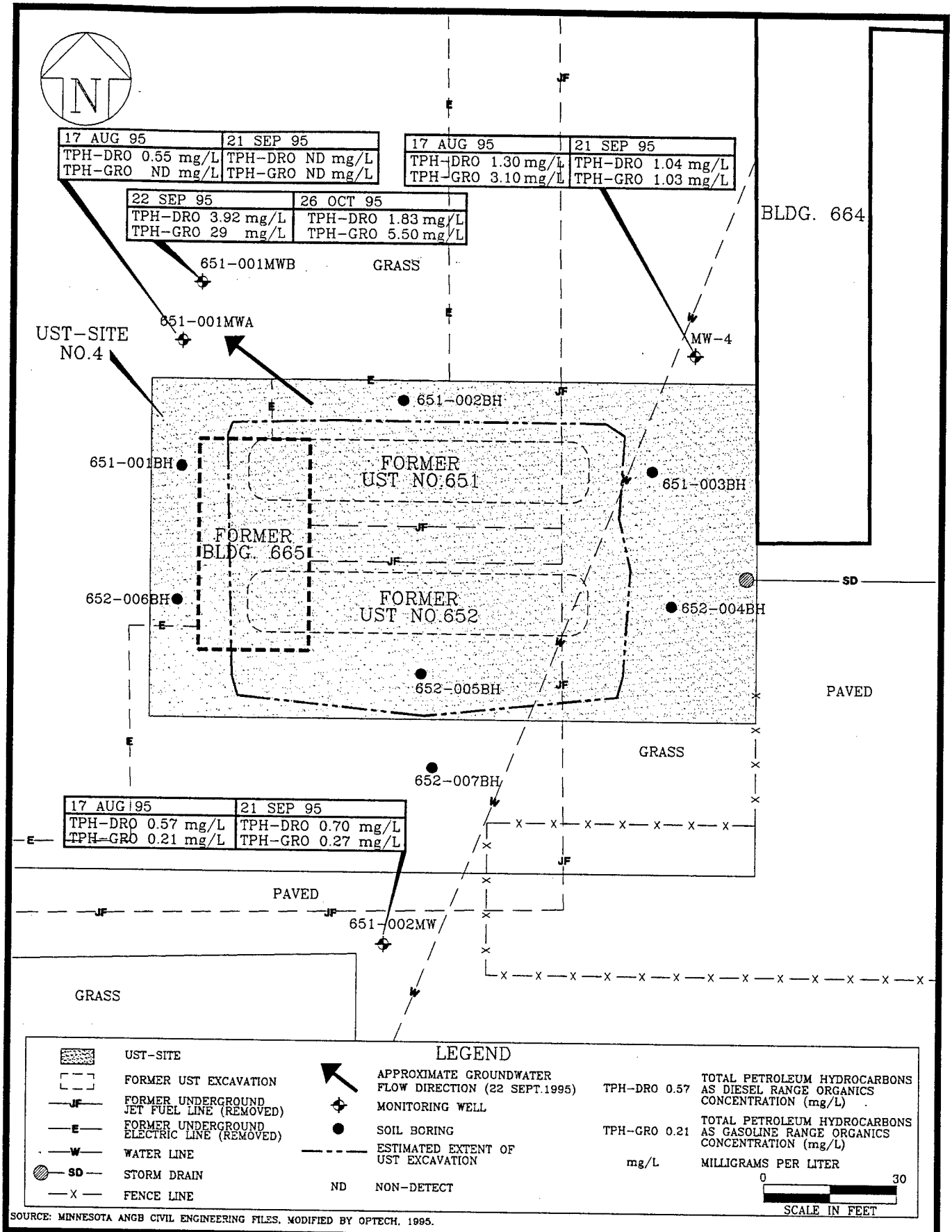

SOURCE: MINNESOTA ANGB CIVIL ENGINEERING FILES, MODIFIED BY OPTECH, 1995.

FIGURE 5.29

MINN\SITE652

TPH-DRO AND TPH-GRO DETECTED IN GROUNDWATER ROUNDS 1 AND 2 UST-SITE NO.4

133rd AW, Minnesota ANGB
Minneapolis, Minnesota

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Table 5.16
Results of TPH-DRO/GRO and Lead Analyses for Groundwater Samples Collected at UST – Site No. 4
133rd AW, Minnesota ANGB, Minneapolis, Minnesota

Sample ID	Sample Date	TPH-DRO (mg/L)	TPH-GRO (mg/L)	Lead (mg/L)
651-001MWA	17 Aug 95	0.55	0.1U	0.1U
651-001MWA DUP	17 Aug 95	0.57	0.1U	0.1U
651-002MW	17 Aug 95	0.57	0.21	0.1U
MW-4	17 Aug 95	1.3	3.1	0.1U
651-003 EB	17 Aug 95	0.05	0.1U	0.1U
Trip Blank	17 Aug 95	NA	NA	NA
MW-4	21 Sep 95	1.04	1.03	0.1U
MW-4 DUP	21 Sep 95	1.10	1.36	0.1U
651-002MW	21 Sep 95	0.70	0.27	0.1U
651-001MWA	21 Sep 95	0.1U	0.1U	0.1U
Trip Blank	21 Sep 95	NA	NA	NA
651-001MWB	22 Sep 95	3.92	29	0.1U
651-001MWB	26 Oct 95	1.83	5.5	0.1U
Trip Blank	26 Oct 95	NA	NA	NA

U – Compound was analyzed for but was not detected. Detection limit is shown.
MW – Monitoring Well.
UST – Underground Storage Tank.
ID – Identification.
µg/kg – micrograms per kilogram.
mg/kg – milligrams per kilogram.
TPH-DRO – Total Petroleum Hydrocarbons-Diesel Range Organics.
TPH-GRO – Total Petroleum Hydrocarbons-Gasoline Range Organics.
NA – Not Analyzed.
DUP – Duplicate.

samples. Only two soil samples exhibited TPH-GRO at concentrations of 50 mg/kg and 0.83 mg/kg. The maximum TPH-GRO concentration was detected in the soil sample collected from a depth of 1.0 to 2.0 feet BLS in soil boring 652-007BH.

Naturally occurring background concentrations of lead in soils in the Eastern United States ranges from <10 to 300 mg/kg (Shacklette and Boerngen, 1984).

Based on the results of previous investigations and the SI, the following conclusions regarding the extent and magnitude of contaminated soil are presented:

- TPH-DRO concentrations at levels of concern were exhibited by soil samples collected from the UST excavation sidewalls and floor during Bay West, Inc.'s, tank removal activities.

- The distribution of petroleum hydrocarbon contaminants detected in soil samples from the SI soil borings indicates that the highest degree of residual soil contamination is restricted to depths less than 2.0 feet below the surface. The shallow occurrence of the contaminated soil is more consistent with impact from a surface source rather than a buried UST system. Potential source candidates for the elevated levels of soil contamination could be surface spillage that occurred during operation of the facility or possibly spillage of residual contaminated soil and backfill removed from the UST excavation. The lateral extent of the near-surface soil contamination has not been delineated.

- The vertical extent of petroleum contamination in native soils outside the UST excavation has been defined to concentrations that do not pose a significant threat to human health or the environment.

- The concentrations of lead detected in soil samples during the SI do not pose a significant threat to human health or the environment.

A water sample collected directly from the UST excavation during the Bay West, Inc., August 1993 removal activities exhibited a total BTEX concentration of 1,894 μg/L (74 μg/L benzene) and a TPH-DRO concentration of 1.9 mg/L. The contamination detected in the water sample represents contact of groundwater with contaminated fill materials within the tank pit and cannot be considered representative of groundwater conditions at the site.

A sheen and strong hydrocarbon odor was noted in groundwater samples collected from monitoring wells 651-001MWA and MW-4. No BTEX was detected in SI groundwater samples collected from monitoring well 651-001MWA, located in the inferred downgradient direction from the UST excavation and screened within the perched water table during the first groundwater sampling event (17 August 1995) or second sampling event (21 September 1995). TPH-DRO was detected in groundwater samples during the first sampling event at a concentration of 0.55 mg/L, but was not detected during the second sampling event.

Total BTEX concentrations in groundwater samples collected from monitoring wells 651-001MWB, 651-002MW, and MW-4, all completed in the shallow confined bedrock aquifer,

ranged from 50 μg/L (benzene at 6 μg/L) from monitoring well 652-002MW to 919 μg/L (benzene at 39 μg/L). No other VOCs were detected in the SI groundwater samples. The MDH HRL for benzene in groundwater is 10 μg/L; the Federal Maximum Cleanup Level (MCL) is 5 μg/L. TPH-DRO concentrations in groundwater samples collected from these monitoring wells ranged from 3.92 mg/L in monitoring well 651-001MWB to 0.57 mg/L in monitoring well 651-002MW. TPH-GRO concentrations in groundwater samples collected from these monitoring wells ranged from 29 mg/L in monitoring well 651-001MWB to 0.21 mg/L in monitoring well 651-002MW.

No lead was detected in any of the groundwater samples collected during the SI.

Based on the results of previous investigations and the SI, the following conclusions regarding the extent and magnitude of contaminated groundwater at the site are presented:

- No petroleum hydrocarbon contamination was indicated in groundwater samples collected from the perched groundwater table at the site.

- Benzene concentrations greater than MDH HRLs and Federal MCLs have been confirmed in groundwater samples collected from the shallow confined aquifer within the Platteville Formation. TPH-DRO and TPH-GRO concentrations at levels of concern have also been confirmed in the groundwater samples; however, no MDH HRLs or Federal MCLs are established for TPH in groundwater. Cleanup levels for groundwater contaminants having no established MDH HRL are determined by the MPCA on a site-specific basis.

- The horizontal extent of petroleum hydrocarbon contamination in groundwater within the shallow confined aquifer was not defined at the site by the SI.

5.4.6 Recommendations

Based on the results of the SI, no further investigative or remedial actions are recommended for soil or groundwater. Site closure should be requested from the MPCA. The recommendation is supported by the following:

- The highest concentration of TPH-DRO was detected in the soil sample collected from soil boring 651-003BH at the 1.0- to 2.0-foot interval. Due to the limited (shallow) vertical extent of soils contaminated by elevated TPH concentrations,

and the relatively low mobility of TPH compounds, the potential for shallow contaminated soils identified during the SI to significantly impact groundwater is low. Contaminated soils do not pose a significant vapor threat. The TPH concentrations detected are low enough that normal human activities at the site would not result in a significant threat to human health. Additionally, site conditions are suitable to allow natural degradation to reduce the level of TPH contamination over time. Therefore, no additional delineation or remedial efforts with respect to shallow soil contamination are warranted.

- Although benzene at concentrations greater than HRLs and Federal MCLs was detected in groundwater samples from monitoring wells completed in the Platteville Limestone, the Platteville is not considered to be an important groundwater resource in the site vicinity. Vertical migration of groundwater from the Platteville is inhibited by confining Glenwood Shale which immediately underlies the Platteville.

- There are no complete groundwater pathways to sensitive receptors at or adjacent to the site. The nearest water wells listed are approximately 3,000 feet away and are not completed within the contaminated interval. Well records indicate that the wells produce groundwater from the Jordan Sandstone which is separated from shallower aquifers by a confining unit.

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SECTION 6.0 LABORATORY QUALITY ASSURANCE RESULTS FOR CONFIRMATION SAMPLES

6.1 VOLATILE ORGANIC COMPOUND SURROGATE RECOVERY

Every laboratory analysis is validated by measuring the recovery of specific compounds which are spiked into all samples. Such compounds are known as surrogates. The recovery of surrogate compounds for an analytical procedure must fall within a range of control limit values for each analysis to be considered valid or compliant with the procedure.

VOC surrogate recoveries for soil samples analyzed by USEPA Method SW8240 from all UST sites ranged from 88% to 96% for 1,2-dichloroethane-d4, from 78% to 98% for 4-bromofluorobenzene, and from 100% to 114% for toluene-d8. The recoveries were all within quality control limits for all three surrogates in all samples. VOC surrogate recoveries for field quality control soil samples analyzed by USEPA Method SW8240 from all UST sites ranged from 76% to 100% for 1,2-dichloroethane-d4, from 80% to 96% for 4-bromofluorobenzene, and from 88% to 112% for toluene-d8. The recoveries were all within quality control limits for all three surrogates in all samples.

VOC surrogate recoveries for water samples analyzed by USEPA Method SW8240 from all UST sites ranged from 92% to 104% for 1,2-dichloroethane-d4, from 88% to 114% for 4-bromofluorobenzene, and from 98% to 104% for toluene-d8. The recoveries were all within quality control limits for all three surrogates in all samples. VOC surrogate recoveries for field quality control water samples analyzed by USEPA Method SW8240 from all UST sites ranged from 92% to 104% for 1,2-dichloroethane-d4, from 92% to 98% for 4-bromofluorobenzene, and from 96% to 102% for toluene-d8. The recoveries were all within quality control limits for all three surrogates in all samples.

Aromatic VOC surrogate recoveries for soil samples analyzed by USEPA Method SW8020 from all UST sites ranged from 75% to 108% for 1,4-difluorobenzene and from 36% to 129% for 4-bromofluorobenzene. The quality control acceptance criteria for the Aromatic VOC surrogate compounds are advisory limits only. This criteria was met for all soil samples. Aromatic VOC surrogate recoveries for field quality control soil samples analyzed by USEPA Method SW8020 from all UST sites ranged from 34% to 102% for 1,4-difluorobenzene and from 94% to 104% for 4-bromofluorobenzene. The quality control acceptance criteria for the aromatic VOC surrogate compounds are advisory limits only. This criteria was met for all field quality control soil samples.

6.2 GASOLINE RANGE ORGANIC SURROGATE RECOVERY

GRO surrogate recoveries for soil samples analyzed by WDNR method from all UST sites ranged from 72% to 103% for 1,4-difluorobenzene and from 53% to 267% for 4-bromofluorobenzene. The quality control acceptance criteria for the GRO surrogate compounds are advisory limits only. This criteria was met for all soil samples. GRO surrogate recoveries for field quality control soil samples analyzed by WDNR method from all UST sites ranged from 79% to 109% for 1,4-difluorobenzene and from 60% to 101% for 4-bromofluorobenzene. The quality control acceptance criteria for the GRO surrogate compounds are advisory limits only. This criteria was met for all field quality control soil samples.

GRO surrogate recoveries for water samples analyzed by WDNR method from all UST sites ranged from 76% to 100% for 1,4-difluorobenzene and from 32% to 107% for 4-bromofluorobenzene. The quality control acceptance criteria for the GRO surrogate compounds are advisory limits only. This criteria was met for all water samples. GRO surrogate recoveries for field quality control water samples analyzed by WDNR method from all UST sites ranged from 93% to 94% for 1,4-difluorobenzene and from 87% to 96% for 4-bromofluorobenzene. The quality control acceptance criteria for the GRO surrogate compounds are advisory limits only. This criteria was met for all field quality control water samples.

6.3 DIESEL RANGE ORGANIC SURROGATE RECOVERY

DRO surrogate recoveries for soil samples analyzed by WDNR method from all UST sites ranged from 1% to 211% for 2-fluorobiphenol and from 1% to 99% for o-terphenyl. There are no recommended surrogates by this state-specific method, and quality control acceptance criteria for the surrogate compounds are advisory limits only. This criteria was met for all soil samples. DRO surrogate recoveries for field quality control soil samples analyzed by WDNR method from all UST sites ranged from 25% to 125% for 2-fluorobiphenyl and from 38% to 120% for o-terphenyl. There are no recommended surrogates by this state-specific method, and quality control acceptance criteria for the surrogate compounds are advisory limits only. This criteria was met for all field quality control soil samples.

DRO surrogate recoveries for water samples analyzed by WDNR method from all UST sites ranged from 10% to 231% for 2-fluorobiphenol and from 49% to 107% for o-terphenyl. There are no recommended surrogates by this state-specific method, and quality control acceptance

criteria for the surrogate compounds are advisory limits only. This criteria was met for all water samples. DRO surrogate recoveries for field quality control water samples analyzed by WDNR method from all UST sites ranged from 43% to 250% for 2-fluorobiphenyl and from 43% to 57% for o-terphenyl. There are no recommended surrogates by this state-specific method, and quality control acceptance criteria for the surrogate compounds are advisory limits only. This criteria was met for all field quality control water samples.

6.4 LEAD SURROGATE RECOVERY

Total lead surrogate recoveries for soil samples analyzed by USEPA Method SW7420 from all UST sites ranged from 87% to 94%. The criteria was met for all soil samples with the quality control surrogate limits of 52% to 119% recovery. Total lead surrogate recoveries for field quality control soil samples analyzed by USEPA Method SW7420 from all UST sites ranged from 83% to 89%. The criteria was met for all field quality control soil samples with the quality control surrogate limits of 52% to 114% recovery.

Total lead surrogate recoveries for water samples analyzed by USEPA Method SW7420 from all UST sites ranged from 93% to 100%. The criteria was met for all soil samples with the quality control surrogate limits of 50% to 110% recovery. Total lead surrogate recoveries for field quality control soil samples analyzed by USEPA Method SW7420 from all UST sites ranged from 80% to 84%. The criteria was met for all field quality control soil samples with the quality control surrogate limits of 50% to 110% recovery.

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SECTION 7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 UST – SITE NO. 1 (FORMER UST 591) – MPCA LEAK NO. 6686

During Bay West's 1993 UST removal activities, no BTEX compounds were detected in soil samples at the site. However, TPH-DRO was detected in one soil sample collected from the UST excavation floor and in one soil sample collected from the vent piping run. During the August 1995 SI, BTEX compounds were found in three investigative soil samples in trace amounts ranging from 1 to 3 μg/kg, and TPH-DRO was detected in one soil sample at a concentration of 4.1 mg/kg (detection limit of 4 mg/kg).

Analysis of groundwater samples, collected from a monitoring well located downgradient of the UST excavation, exhibited a maximum TPH-DRO concentration of 0.36 mg/L. No MDH HRLs for drinking water have been established for TPH-DRO.

7.1.1 Conclusions

The levels of BTEX and TPH-DRO contamination detected during the SI are not considered to be harmful to human health or the environment.

Based on the results of groundwater analyses conducted during the SI, minimal groundwater impact from TPH-DRO has occurred at the site. The levels of TPH-DRO detected in the groundwater samples are generally not considered to be harmful to human health or the environment.

7.1.2 Recommendations

Based on the results of previous investigations and this SI, no further investigative or remedial actions for soil and groundwater are warranted. Site closure should be requested from the MPCA.

7.2 UST – SITE NO. 2 (FORMER UST 873) – MPCA LEAK NO. 6685

No VOCs were detected in soil samples collected from the UST excavation during Bay West, Inc.'s, August 1993 UST removal activities. TPH-DRO was detected at a concentrations of 9 and 24 mg/kg during the UST removal activities in soil samples collected from the sidewalls of the UST excavation floor.

During the August 1995 SI, no VOCs were detected in the six investigative soil samples collected from the delineation soil borings. TPH-DRO was detected at a concentration of 290 mg/kg in a near-surface (1.5 to 2.5 feet BLS) soil sample. TPH-DRO concentrations decreased rapidly with depth within the soil profile to 18 mg/kg or less.

VOCs detected in a water sample collected directly from the UST excavation during the Bay West, Inc., August 1993 removal activities represented contact of groundwater with contaminated materials within the UST excavation and cannot be considered representative of groundwater conditions in native soils at the site.

During the August 1995 SI, analyses of groundwater samples, collected from the monitoring well located in the inferred downgradient direction from the UST excavation, exhibited a maximum TPH-DRO concentration of 0.11 mg/L (detection limit of 0.1 mg/L) during the first round of groundwater sampling. No TPH-DRO was detected in groundwater samples collected during the second round of groundwater sampling.

7.2.1 Conclusions

Results of the SI indicate that elevated concentrations of TPH-DRO at the site are restricted to the upper few feet of the soil profile, underneath the asphalt paving and subgrade. Based on the distribution and magnitude of TPH-DRO contamination, the potential for significant impact to groundwater is low.

Based on the results of groundwater analyses conducted during the SI, no groundwater contamination has been confirmed outside of the UST excavation at the site.

7.2.2 Recommendations

Based on the results of previous investigations and this SI, no further investigative or remedial actions outside of the UST excavation are warranted. Site closure should be requested from the MPCA.

7.3 UST – SITE NO. 3 (FORMER UST 801) – MPCA LEAK NO. 6621

During Bay West, Inc.'s UST removal activities in September 1993, BTEX constituents were detected in soil samples from the excavation floor (13.0 feet BLS) at concentrations ranging up

to 14 mg/kg, and TPH-DRO was detected in the excavation floor samples at concentrations ranging from 880 to 12,000 mg/kg.

During the August 1995 SI, one soil sample collected from a depth of 9.0 to 10.0 feet BLS exhibited a total BTEX concentration of 6.26 mg/kg (the duplicate sample exhibited 11.7 mg/kg). Total BTEX concentrations in the other soil samples collected at the site were less than 0.005 mg/kg. TPH-DRO was detected in a soil sample from the 9.0- to 10.0-foot interval at a concentration of 2,100 mg/kg but was relatively low in other sample intervals (ranging from 8.3 to 15 mg/kg).

A water sample collected directly from the UST excavation during the Bay West, Inc., August 1993 removal activities exhibited a total BTEX concentration of 203 μg/L (13 μg/L benzene) and a TPH-DRO concentration of 30 mg/L.

During the 1995 SI, analyses of groundwater samples, collected from the monitoring well located in the inferred downgradient direction from the UST excavation, exhibited a maximum TPH-DRO concentration of 0.19 mg/L (detection limit of 0.1 mg/L) during the first round of groundwater sampling. No TPH-DRO was detected in groundwater samples collected from the monitoring well during the second round of groundwater sampling. No VOCs were detected in any of the groundwater samples.

7.3.1 Conclusions

Based on the delineation results of the SI, soil contamination at elevated levels exists as residual concentrations of BTEX and TPH-DRO at a depth of approximately 10.0 feet BLS, just above bedrock and adjacent to the north edge of the UST excavation. Petroleum contaminant concentrations detected in soil are not considered great enough to pose a significant vapor threat. The concentrations detected are consistent with residual contamination levels detected in excavation floor samples collected during the 1993 UST removal activities. The northern extent of petroleum hydrocarbon contamination has not been determined.

The contamination detected in the water sample collected during the 1993 UST removal represents contact of groundwater with contaminated fill materials within the tank pit and cannot be considered representative of groundwater conditions at the site. During the 1995 SI, no significant groundwater contamination was identified.

7.3.2 Recommendations

Based on the results of the SI, no further investigative or remedial actions are warranted. Site closure should be requested from the MPCA. The recommendations are supported by the following:

- The contamination source has been removed, and residual contaminated soils are within a restricted area and are not exposed.

- Groundwater contamination at levels of concern has not been detected.

- There are no complete exposure pathways to sensitive receptors for soil or groundwater contamination. The nearest water wells listed are approximately 3,000 feet away and are not completed within the contaminated interval. Well records indicate that the wells produce groundwater from the Jordan Sandstone which is separated from shallower aquifers by a confining unit. Contaminated soils are not exposed and do not pose a significant vapor threat.

7.4 UST – SITE NO. 4 (FORMER USTs 651/652) – MPCA LEAK NO. 6580

During the previous investigation, conducted during Bay West, Inc.'s UST removal activities in September 1993, BTEX constituents were detected in soil samples from the excavation floor and sidewalls at concentrations ranging from non-detect to 8.5 mg/kg; no benzene was detected. TPH–DRO was detected in all soil samples at concentrations ranging from 150 mg/kg to 840 mg/kg.

During the August 1995 SI, the highest BTEX concentrations were detected in near-surface soil samples at a maximum concentration of 2.2 mg/kg. Total BTEX concentrations in all soil samples collected from depths greater than 2.0 feet BLS ranged from 0.001 to 0.187 mg/kg (maximum benzene concentration of 0.036 mg/kg).

TPH-DRO concentrations detected in the SI soil samples collected from depth intervals less than 5.0 feet BLS ranged from non-detect to 320 mg/kg; no TPH-DRO was detected at depths greater than 5.0 feet BLS. TPH-GRO was detected in two soil samples only at concentrations of 50 mg/kg and 0.83 mg/kg, the higher concentration detected in a sample collected from a depth of 1.0 to 2.0 feet BLS.

A water sample collected directly from the UST excavation during the Bay West, Inc. August 1993 removal activities exhibited a total BTEX concentration of 1,894 μg/L (74 μg/L benzene) and a TPH-DRO concentration of 1.9 mg/L. The contamination detected in the water sample represents contact of groundwater with contaminated fill materials within the tank pit and cannot be considered representative of groundwater conditions at the site.

During the 1995 SI, a sheen and strong hydrocarbon odor was noted in groundwater samples collected from two monitoring wells. During both the first and second groundwater sampling events (August 1995 and September 1995, respectively), no BTEX was detected in groundwater samples collected from the monitoring well located in the inferred downgradient direction from the UST excavation and screened within the perched water table. TPH-DRO was detected in groundwater samples during the first sampling event at a concentration of 0.55 mg/L, but was not detected during the second sampling event.

Total BTEX concentrations in groundwater samples collected from monitoring wells completed in the shallow confined bedrock aquifer ranged from 50 μg/L (benzene at 6 μg/L) to 919 μg/L (benzene at 39 μg/L). No other VOCs were detected in the SI groundwater samples. The MDH HRL for benzene in groundwater is 10 μg/L; the Federal MCL is 5 μg/L. TPH-DRO concentrations in groundwater samples collected from these monitoring wells ranged from 0.57 mg/L to 3.92 mg/L. TPH-GRO concentrations in groundwater samples collected from these monitoring wells ranged from 0.21 mg/L to 29 mg/L.

No lead was detected in any of the groundwater samples collected during the SI.

7.4.1 Conclusions

Based on the results of previous investigations and the SI, the following conclusions regarding the extent and magnitude of contaminated soil are presented:

- TPH-DRO concentrations at elevated levels were exhibited by soil samples collected from the UST excavation sidewalls and floor during Bay West, Inc.'s tank removal activities.

- The distribution of petroleum hydrocarbon contaminants detected in soil samples from the SI soil borings indicates that the highest degree of residual soil contamination is restricted to depths less than 2.0 feet below surface. The shallow occurrence of the contaminated soil is more consistent with impact from

a surface source rather than a buried UST system. Potential source candidates for the elevated levels of soil contamination could be surface spillage that occurred during operation of the facility or possibly spillage of residual contaminated soil and backfill removed from the UST excavation. The lateral extent of the near-surface soil contamination was not delineated.

- The vertical extent of petroleum contamination in native soils outside the UST excavation has been defined to concentrations that do not pose a significant threat to human health or the environment.

- The concentrations of lead detected in soil samples during the SI do not pose a significant threat to human health or the environment.

Based on the results of previous investigations and the SI, the following conclusions regarding the extent and magnitude of contaminated groundwater at the site are presented:

- No petroleum hydrocarbon contamination was indicated in groundwater samples collected from the perched groundwater table at the site.

- Benzene concentrations greater than MDH HRLs and Federal MCLs have been confirmed in groundwater samples collected from the shallow confined aquifer within the Platteville Formation. TPH-DRO and TPH-GRO concentrations at levels of concern have also been confirmed in the groundwater samples; however, no MDH HRLs or Federal MCLs are established for TPH in groundwater. Cleanup levels for groundwater contaminants having no established MDH HRL are determined by the MPCA on a site-specific basis.

- The horizontal extent of petroleum hydrocarbon contamination in groundwater within the shallow confined aquifer was not defined at the site by the SI.

7.4.2 Recommendations

Based on the results of the SI, no further investigative or remedial actions are recommended for soil or groundwater. Site closure should be requested from the MPCA. The recommendations are supported by the following:

- The highest concentration of TPH-DRO was detected in the soil sample collected from soil boring 651-003BH at the 1.0- to 2.0-foot interval. Due to the limited (shallow) vertical extent of soils contaminated by elevated TPH concentrations, and the relatively low mobility of TPH compounds, the potential for shallow contaminated soils identified during the SI to significantly impact groundwater is low. Contaminated soils do not pose a significant vapor threat. The TPH concentrations detected are low enough that normal human activities at the site would not result in a significant threat to human health. Additionally, site conditions are suitable to allow natural degradation to reduce the level of TPH contamination over time. Therefore, no additional delineation or remedial efforts with respect to shallow soil contamination are warranted.

- Although benzene at concentrations greater than HRLs and Federal MCLs was detected in groundwater samples from monitoring wells completed in the Platteville Limestone, the Platteville is not considered to be an important groundwater resource in the site vicinity. Vertical migration of groundwater from the Platteville is inhibited by confining Glenwood Shale which immediately underlies the Platteville.

- There are no complete groundwater pathways to sensitive receptors at or adjacent to the site. The nearest water wells listed are approximately 3,000 feet away and are not completed within the contaminated interval. Well records indicate that the wells produce groundwater from the Jordan Sandstone which is separated from shallower aquifers by a confining unit.

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